Big Sagebrush
Plant Associations
Of the Pinedale Ranger District
Final Review Draft August 1996

Bridger-East Ecological Unit Inventory
Bridger-Teton National Forest

Big Sagebrush Plant Associations of the Pinedale Ranger District

Final Review Draft August 1996

Bridger-East Ecological Unit Inventory Bridger-Teton National Forest

David L. Tart, Ecologist

Acknowledgements

Thanks to Dr. Alma Winward for serving as my mentor on this project and patiently teaching me to identify sagebrush (including how to look at it with a garbage bag over my head).

In addition to the author, vegetation data for this classification was collected by Norm Merz of the Wyoming Department of Game and Fish, Haans Fisk, Erik Lindquist, Wendy Goetz, Martin Ferwerda, and John Ramos. Soil pedon descriptions were done by Terry Svalberg, Donald Fallon, Martin Ferwerda, and John Ramos.

Various parts of this manuscript were reviewed by Alma Winward, Erik (“the red pen") Lindquist, Terry Svalberg, Haans Fisk, Debbie DesLaurier, Barb Franklin, Jeff Hatch, and Jim Keller.

Thanks to Daryle Bennett of the Natural Resource Conservation Service and Ann Mebane for providing precipitation data for the study area.

Distribution and plot location maps were prepared by Erik Linquist

Table of Contents

Introduction……1

Classification Concepts and Terminology……1

Plant Taxonomy……1

Study Area……3

Distribution of Big Sagebrush Taxa……4

Overview of PNV Classification……7

- Mountain Big Sagebrush Series……7
- Vasey Big Sagebrush Series……8
- Subalpine Big Sagebrush Series……8
- Relationship of PNV Types to Environmental Factors……9

Keys to *Artemisia tridentata* PNV Types……13

- Floristic Key……13
- Biophysical Key……16

Plant Association and Subseries Descriptions……22

- Mountain big sagebrush - antelope bitterbrush / bluebunch wheatgrass p.a. ……24
- Mountain big sagebrush / Idaho fescue - bluebunch wheatgrass p.a. ……29

- Vasey big sagebrush - antelope bitterbrush Subseries……35
- Vasey big sagebrush / Idaho fescue - bluebunch wheatgrass p.a. ……40
- Vasey big sagebrush - mountain snowberry Subseries……45
- Vasey big sagebrush / Richardson's needlegrass p.a. ……50
- Vasey big sagebrush / slender wheatgrass p.a. ……55
- Vasey big sagebrush / spike trisetum p.a. ……60

- Subalpine big sagebrush / slender wheatgrass p.a. ……65
- Subalpine big sagebrush / spike trisetum p.a. ……70

Literature Cited ……75

Appendices

1. Plant List ……77
2. Sagebrush Taxonomy……84
3. Field Sampling and Data Analysis Methods……88
4. Procedure for Estimating Mean Annual Precipitation……90
5. Comparison to Preliminary Classification ……96
6. Evidence of Animal Use by PNV Type ……97

List of Tables

1. Classification of Big Sagebrush Plant Associations and Subseries……2

2. Relationship of Subsections to the National Hierachy of Ecological Units……5

3. Areal Extent of Big Sagebrush Series by Subsection within the EUI Survey Area……...5

4. Distribution of Diagnostic Species Across the Big Sagebrush PNV Types……11

5. Mean Environmental Parameters and AWC for Big Sagebrush PNV Types……..12

6. Comparative Morphology of Three Taxa of Big Sagebrush ……..84

7. Mean Annual Precipitation as a Function of Elevation by Climatic Zone……92

8. Yearly Precipitation for Long and Short Term Stations ……94

List of Figures

1. Bridger-East EUI survey area and subsections……..4

2. Distribution of big sagebrush taxa along gradients of mean annual precipitation and soil available water capacity……..6

3. Mean monthly soil temperature values for sites occupied by mountain, Vasey, and subalpine big sagebrush ……...7

4. Distribution of big sagebrush PNV types along a temperature-moisture gradient……9

5. Map of Climatic Zones for Estimating Mean Annual Precipitation……91

Introduction

This report presents a classification of big sagebrush (*Artemisia tridentata*) plant associations occurring on the Pinedale Ranger District of the Bridger-Teton National Forest. This classification was developed as part of the Bridger-East Ecological Unit Inventory (EUI). An EUI consists of classifying ecological types and mapping ecological units. Ecological types are ecosystem classification units based on potential natural vegetation (PNV), soils, geology, landform, and climate. Ecological units are ecosystem mapping units comprised of one to three ecological types that occur together in a repeating pattern.

Shrublands dominated by big sagebrush are a significant component of the landscape on the portions of the Pinedale Ranger District managed for multiple use. However, no classification of big sagebrush potential natural communities had been done prior to the Bridger-East EUI. Since PNV is essential for defining ecological types, a PNV classification for big sagebrush shrublands became a necessary part of the Bridger-East EUI.

This classification is a refinement of a preliminary classification of big sagebrush plant associations developed and reported earlier (Tart 1994). This report includes a detailed description of the biotic and physical characteristics of each plant association, a discussion of the management implications of each association, and a key for identifying the plant associations in the field.

Classification Concepts and Terminology

The **potential natural vegetation** of an area is the vegetation that would develop if plant succession was completed without human-caused disturbance under present environmental conditions (USDA Forest Service 1991). Knowing the PNV of a site allows us to infer some of its environmental attributes and to anticipate its response to management treatments or disturbances.

Potential natural vegetation can be classified at several levels of taxonomic detail. A potential natural plant community of definite floristic composition and uniform structure is called a **plant association** (p.a.). A plant association is usually characterized by several species that occur together over a relatively narrow range of environmental conditions. Classification of plant associations is based on species composition, the dominant species in each vegetation layer (*e.g.* trees, shrubs, herbs), and indicator species. The latter are plant species that occur within a particular range of environmental factors, but do not necessarily dominate the plant community.

Broader levels of PNV classification can be formed by grouping plant associations together. All plant associations with the same dominant species in the dominant layer are called a **series**. Within a series, smaller groups of plant associations may be defined based on similarity in species composition, codominant species, and/or environmental factors. Such a group is called a **subseries**.

This big sagebrush PNV classification includes eight plant associations and two subseries. These ten PNV types are grouped into three series based on the dominant taxa of big sagebrush (Table 1). The field sampling and data analysis methods used to develop this PNV classification are described in Appendix 3.

Plant Taxonomy

Plant names follow the second edition of *Vascular Plants of Wyoming* (Dorn 1992) except where noted below. Appendix 1 lists the scientific name, common name, and computer code of each plant taxon found to date in big sagebrush stands on the Pinedale Ranger District.

Big sagebrush taxa have been identified and named according to Goodrich *et al*. (1985). Three different taxa have been used to classify plant associations on the Pinedale Ranger District:

Artemisia tridentata ssp. *spiciformis*	subalpine big sagebrush
Artemisia tridentata var. *vaseyana*	Vasey big sagebrush
Artemisia tridentata var. *pauciflora*	mountain big sagebrush

Table 1. Classification of Big Sagebrush Plant Associations and Subseries

Common and Scientific Names	Abbreviation (Code)
Mountain big sagebrush Series	
Mountain big sagebrush - antelope bitterbrush / bluebunch wheatgrass p.a. *Artemisia tridentata* var. *pauciflora - Purshia tridentata / Elymus spicatus*	ARTRP4-PUTR2/ELSP3
Mountain big sagebrush / Idaho fescue - bluebunch wheatgrass p.a. *Artemisia tridentata* var. *pauciflora / Festuca idahoensis - Elymus spicatus*	ARTRP4/FEID-ELSP3
Vasey big sagebrush Series	
Vasey big sagebrush - antelope bitterbrush Subseries *Artemisia tridentata* var. *vaseyana - Purshia tridentata*	ARTRV2-PUTR2
Vasey big sagebrush / Idaho fescue - bluebunch wheatgrass p.a. *Artemisia tridentata* var. *vaseyana / Festuca idahoensis - Elymus spicatus*	ARTRV2/FEID-ELSP3
Vasey big sagebrush - mountain snowberry Subseries *Artemisia tridentata* var. *vaseyana - Symphoricarpos oreophilus*	ARTRV2-SYOR2
Vasey big sagebrush / Richardson's needlegrass p.a. *Artemisia tridentata* var. *vaseyana / Stipa richardsonii*	ARTRV2/STRI2
Vasey big sagebrush / slender wheatgrass p.a. *Artemisia tridentata* var. *vaseyana / Elymus trachycaulus*	ARTRV2/ELTR7
Vasey big sagebrush / spike trisetum p.a. *Artemisia tridentata* var. *vaseyana / Trisetum spicatum*	ARTRV2/TRSP2
Subalpine big sagebrush Series	
Subalpine big sagebrush / slender wheatgrass p.a. *Artemisia tridentata* ssp. *spiciformis / Elymus trachycaulus*	ARTRS2/ELTR7
Subalpine big sagebrush / spike trisetum p.a. *Artemisia tridentata* ssp. *spiciformis / Trisetum spicatum*	ARTRS2/TRSP2

Variety *vaseyana* and variety *pauciflora* are subdivisions of subspecies *vaseyana* (Goodrich *et al*. 1985). The morphological distinctions of these three taxa are described in Appendix 2.

These taxa have been used to define three series of big sagebrush plant associations (Table 1). This is a major change from the preliminary classification which did not separate these three taxa in defining plant associations (Tart 1994). Ecologically, these three taxa occur in different environments and respond differently to disturbances. The environmental differences are described later in this report. Subalpine big sagebrush resprouts after fire and can layer when stems come in contact with soil (Goodrich *et al*. 1985). Vasey and mountain big sagebrush do not resprout after fire, but they do have seeds that germinate in response to the heat of a fire (Champlin and Winward 1982). Vasey big sagebrush has some ability to layer but mountain big sagebrush does not (Winward, personal communication).

Other plant names used in this report that differ from Dorn (1992) are as follows:

Artemisia cana ssp. *viscidula*	(*A. cana* var. *viscidula* in Dorn)
Artemisia longiloba	(*A. arbuscula* var. *longiloba* in Dorn)
Artemisia tridentata ssp. *wyomingensis*	(*A. tridentata* var. *wyomingensis* in Dorn)
Berberis repens	(*Mahonia repens* in Dorn)
Hesperochloa kingii	(*Leucopoa kingii* in Dorn)

The above *Artemisia* nomenclature follows Beetle and Johnson (1982). *Berberis repens* and *Hesperochloa kingii* are used by Steele *et al*. (1983) to name forested plant associations.

Study Area

This plant association classification was developed within the survey area of the Bridger-East EUI. This encompasses most of the Pinedale Ranger District, which is located in western Wyoming along the western flank of the Wind River Mountains. The survey area totals about 747,000 acres. Of this area, about 453,000 acres are managed as wilderness and 294,000 acres are managed for multiple use (*e.g.*. watershed, wildlife habitat, livestock grazing, recreation, and timber production).

Within the survey area, elevation ranges from 7,200 to 13,804 feet and mean annual precipitation ranges from 10 to 60 inches. Most of the precipitation comes in the form of snow. Physiography varies from granitic alpine peaks and tundra at high elevations to sedimentary valleys and morainal foothills at low elevations. The EUI pre-mapping process stratified the survey area into five broad physiographic areas based on gross differences in geomorphology, landforms, climate, and vegetation. Within the *National Hierarchical Framework of Ecological Units* (USDA Forest Service 1993), these five areas make up all or part of five subsections. The location of these five subsections in relation to the survey area are shown in figure 1. The position of these subsections in the national ecosystem hierarchy is shown in Table 2. Each subsection is briefly described below. See the Bridger-East EUI report for more detailed descriptions.

The **Wind River Summit Ridges and Peaks Subsection** consists of rugged alpine peaks, ridges, and glacially scoured cirques and valleys. Parent materials include granite, gneiss, diorite, granodiorite, and metagabbro. Elevation typically ranges from 10,000 to 13,000 feet and mean annual precipitation is typically between 30 and 60 inches. The major vegetation types are alpine tundra and riparian shrublands. No big sagebrush communities occur in this subsection.

The **Subsummit Uplands Subsection** consists of a high elevation erosion surface and glacial troughs formed during the last major glaciation, and a steep mountain front that drops from the erosion surface down to the adjoining foothills. Parent materials include granite, gneiss, granodiorite, and migmatite. Elevation typically ranges from 7,300 to 11,800 feet and mean annual precipitation is typically between 12 and 60 inches. The major vegetation types are coniferous forests, riparian communities, and tundra. Mountain big sagebrush communities are a minor landscape component at lower elevations along the mountain front and in some of the glacial troughs. Vasey and subalpine big sagebrush are occasionally present.

The **Union Pass Uplands Subsection** consists of a broad glaciated valley, a broad till plain, and sedimentary ridges of the southeastern Gros Ventre Range. Parent materials are predominantly sedimentary rocks, including sandstone, limestone, and shale. Many glaciated areas contain large amounts of granitic rocks carried in by glaciers from the adjacent Wind River Mountains. Elevation typically ranges from 7,600 to 11,600 feet. Mean annual precipitation is typically between 20 and 50 inches. The major vegetation types are coniferous forests, Vasey and subalpine big sagebrush shrublands, and riparian shrublands.

The **Upper Green River Basin Subsection** consists of morainal foothills and outwash plains along the western flank of the Wind River Mountains. Parent materials are predominantly granitic rocks, but Tertiary sedimentary deposits are also present. Elevation typically ranges from 7,300 to 9,100 feet and mean annual precipitation is typically between 11 and 25 inches. The major vegetation types are mountain big sagebrush shrublands, aspen forests, and coniferous forests. Vasey big sagebrush dominates instead of mountain big sagebrush wherever sedimentary parent materials predominate.

The **Southeastern Wind River Mountains Subsection** consists of glaciated and unglaciated mountain sideslopes and ridges. Parent materials are mostly granite and granodiorite, but also include schist, sandstone, conglomerates, and claystone. Elevation typically ranges from 7,600 to 10,900 feet. Mean annual precipitation is typically between 12 and 40 inches. The major vegetation types are coniferous forests, aspen forests, big sagebrush shrublands, and riparian herblands. Vasey and subalpine big sagebrush occur occasionally.

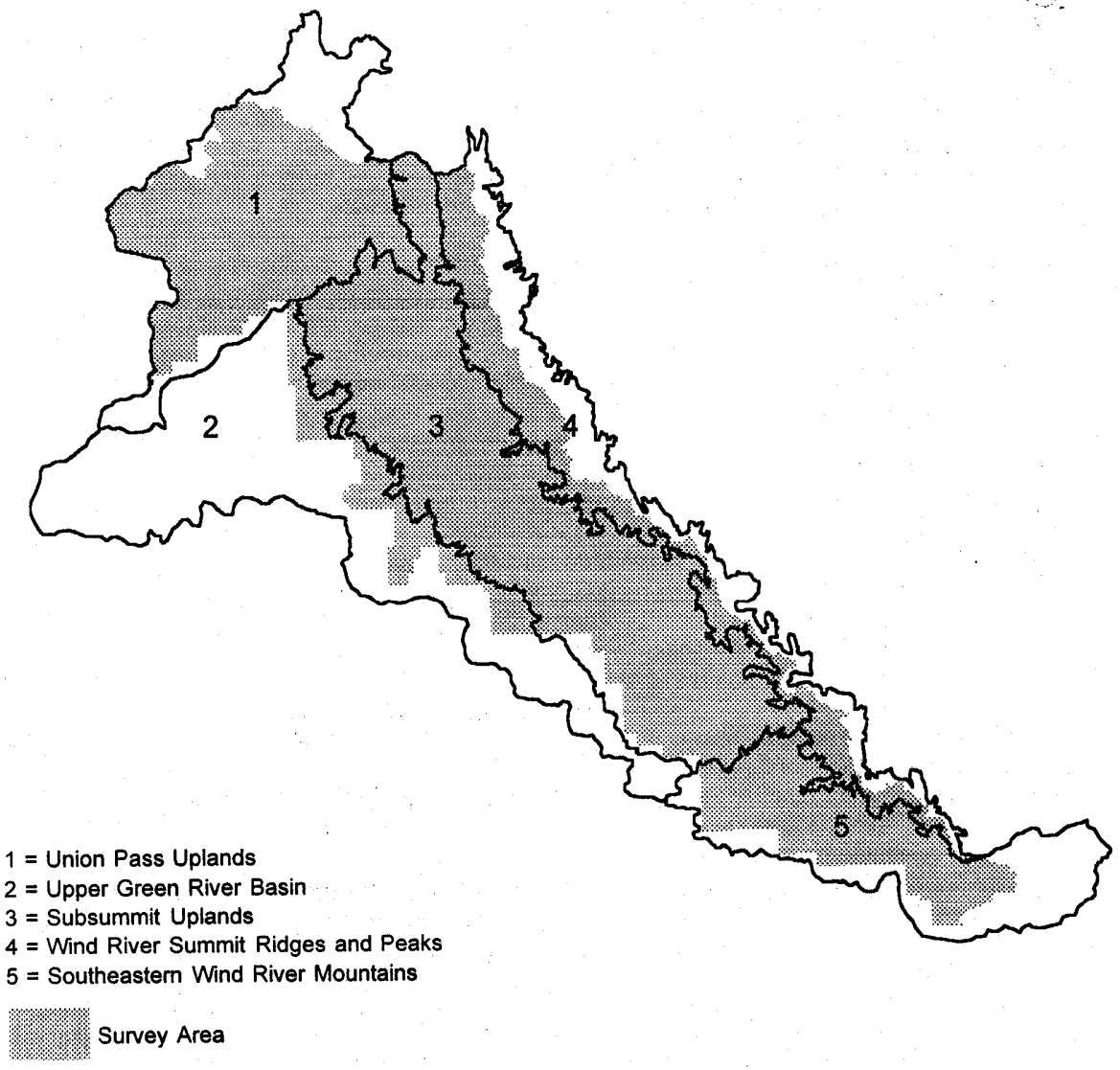


Figure 1. Bridger-East EUI survey area and subsections.

Distribution of Big Sagebrush Taxa

Big sagebrush shrublands are a major component in three of the subsections and a minor component of one subsection (Table 2). The Bridger-East EUI provides two ways of describing the extent of a PNV type. The **geographic extent** is the total acreage of the ecological map units in which the PNV type is a major component. The **areal extent** of a PNV type is the acreage within the geographic extent actually occupied by the type. Since ecological map units usually have more than one component and contain inclusions, the areal extent is always smaller than the geographic extent. Within the Bridger-East EUI survey area, big sagebrush communities have a geographic extent of about 140,000 acres and an areal extent of about 60,000 acres. Nearly all of the big sagebrush occurs in the multiple use portion of the Pinedale Ranger District. Big sagebrush communities occur elsewhere on the district as a minor component or “inclusion.”

Table 2. Relationship of Subsections to the National Hierarchy of Ecological Units.

Ecological Unit Name [1]	Role of Big Sagebrush
Dry Domain	
Temperate Steppe Regime Mountains Division	
Southern Rocky Mountains Province	
Overthrust Mountains Section	
Union Pass Uplands Subsection	Major component
Wind River Mountains Section	
Wind River Summit Ridges and Peaks Subsection	None Present
Subsummit Uplands Subsection	Minor Component
Southeastern Wind River Mountains Subsection	Major Component
Temperate Desert Division	
Intermountain Semi-Desert Province	
Green River Basin Section	
Upper Green River Basin Subsection	Major Component

1. From Ecoregions and Subregions of the United States (USDA Forest Service 1993).

The geographic distribution of the three big sagebrush taxa across the survey area are determined by environmental conditions and soil properties. These factors differ between subsections due to differences in climate, topography, and parent materials. As a result, the extent of big sagebrush and the predominant taxon vary between subsections. These relationships were used in developing the plant association classification and in writing keys to identify the plant associations in the field. Table 3 lists the approximate acreage of each big sagebrush series within the survey area and by subsection.

The two most useful factors for portraying the environmental distribution of mountain, Vasey, and subalpine big sagebrush on the Pinedale Ranger District are mean annual precipitation and the available water capacity (AWC) of the soil (figure 2). Mean annual precipitation is a function of elevation and regional weather patterns (*e.g.* storm tracks). Precipitation was estimated for each sample plot using precipitation data from several weather stations within the survey area and the plot's elevation. (This procedure is described in Appendix 4.) Available water capacity is determined by soil depth, texture, and rock content. AWC was calculated to a depth of 40 inches or a restrictive layer, whichever was less.

Table 3. Areal Extent of Big Sagebrush Series by Subsection within the EUI Survey Area.

Subsection	Mountain Big Sagebrush	Vasey Big Sagebrush	Subalpine Big Sagebrush	Subsection Total
Union Pass Uplands	----------	21,200	9,800	31,000
Upper Green River Basin	15,400	1,400	----------	16,800
Subsummit Uplands	4,100	----------	----------	4,100
Southeastern Wind River Mountains	7,600	----------	----------	7,600
Series Total	27,100	22,600	9,800	59,500

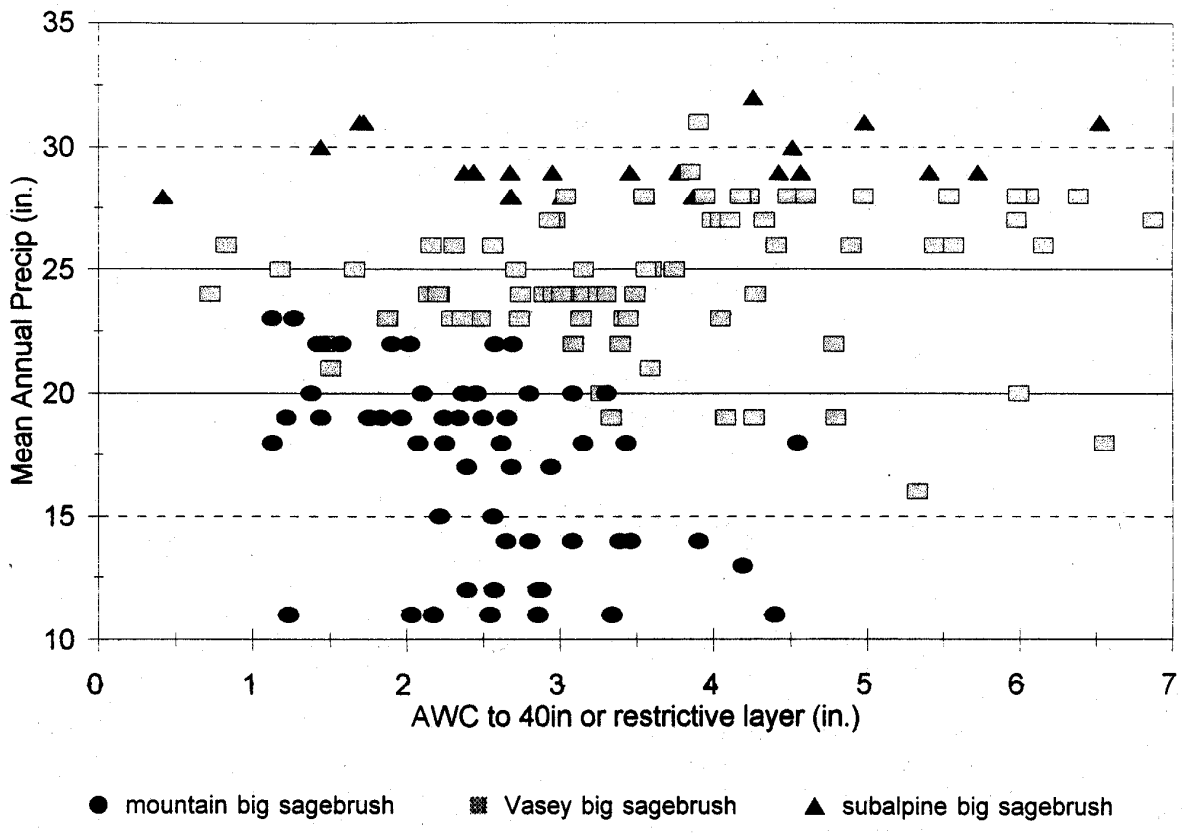


Figure 2. Distribution of big sagebrush taxa along gradients of mean annual precipitation and soil available water capacity.

Figure 2 indicates that subalpine big sagebrush occurs on sites with relatively high precipitation. Its distribution does not appear to be affected by AWC. Precipitation increases with elevation and temperature decreases with elevation. Therefore, the precipitation gradient in figure 2 is also, to some extent, a temperature gradient. Soil temperature data from the Bridger-East EUI shows that sites occupied by subalpine big sagebrush are cooler than those occupied by Vasey big sagebrush (figure 3).

Figure 2 shows that mountain big sagebrush occurs on sites with relatively low precipitation and low AWC. On sites with higher precipitation and/or AWC mountain big sagebrush is replaced by Vasey big sagebrush. Mean annual precipitation and AWC appear to be compensating factors in the distribution of these two varieties of big sagebrush. Soil temperature data shows that sites occupied by mountain big sagebrush are warmer than those occupied by Vasey big sagebrush (figure 3).

The distribution of big sagebrush taxa across the Pinedale Ranger District follows a moisture-temperature gradient that is a function of elevation, weather patterns, aspect, slope, soil properties, and geologic parent materials. Mountain big sagebrush occupies the driest and warmest sites and subalpine big sagebrush occupies the coolest and wettest sites. Vasey big sagebrush occupies sites that are intermediate in moisture and temperature.

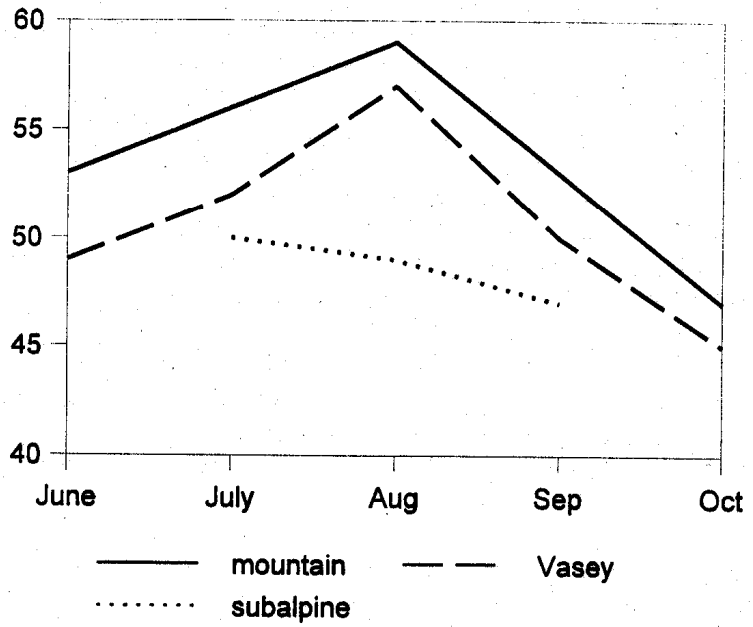


Figure 3. Mean monthly soil temperature (°F) values for sites occupied by mountain, Vasey, and subalpine big sagebrush.

Overview of the PNV Classification

The big sagebrush PNV types of the Pinedale Ranger District are described below by series. Each series description includes its environmental setting, major associated species, and the plant associations and subseries within the series.

Mountain Big Sagebrush Series

The Mountain big sagebrush (or ARTRP4) Series is a significant landscape component in the Upper Green River Basin and Southeastern Wind River Mountains Subsections, and a minor component in the Subsummit Uplands Subsection (Table 3). It occurs mostly on glacial till derived from granitic materials. It also occurs on granitic colluvium and residuum, and on glacial till of mixed granitic and sedimentary materials. Within the survey area, the ARTRP4 Series ranges from 7,300 to 9,250 feet in elevation. It also occurs at lower elevations off the Pinedale Ranger District. Mean annual precipitation ranges from 11 to 23 inches, with an average of 17 inches. Much of this falls as snow and is subject to loss through sublimation and blowing.

The major species associated with mountain big sagebrush are bluebunch wheatgrass (*Elymus spicatus*), antelope bitterbrush (*Purshia tridentata*), Idaho fescue (*Festuca idahoensis*), and arrowleaf balsamroot (*Balsamorhiza sagittata*). Utah mountain snowberry (*Symphoricarpos oreophilus* var. *utahensis*) and creeping Oregon-grape (*Berberis repens*) are also common. Bluebunch wheatgrass, bitterbrush, and balsamroot occur throughout the environmental range of the ARTRP4 Series. At the warm, dry end of its range Idaho fescue is absent or restricted to favored microsites. On cooler, moister sites Idaho fescue dominates the understory or codominates with bluebunch wheatgrass. The abundance of Idaho fescue has been use to divide the ARTRP4 Series into the following two plant associations:

Mountain big sagebrush - antelope bitterbrush / bluebunch wheatgrass p.a. (ARTRP4-PUTR2/ELSP3)
Mountain big sagebrush / Idaho fescue - bluebunch wheatgrass p.a. (ARTRP4/FEID-ELSP3)

The ARTRP4-PUTR2/ELSP3 p.a. occurs on steeper, more southerly slopes and at lower elevations than the ARTRP4/FEID-ELSP3 p.a.

Vasey Big Sagebrush Series

The Vasey big sagebrush (or ARTRV2) Series is a major landscape component in the Union Pass Uplands Subsection and a minor component in the Upper Green River Basin Subsection (Table 3). It occurs mostly on glacial till or colluvium derived from sedimentary materials, or from mixed granitic and sedimentary materials. It also occurs on alluvium or residuum. The ARTRV2 Series ranges in elevation from 7,600 to
9,600 feet. Mean annual precipitation ranges from 14 to 31 inches, with an average of 24 inches. At the high end of its range the ARTRV2 Series occurs on southerly aspects or exposed sites where snow is lost through sublimation or blowing. At the low end of its range, Vasey big sagebrush usually occurs on fine textured soils with relatively high water holding capacities (figure 2).

Idaho fescue is present throughout the range of the ARTRV2 Series and usually dominates the understory. At the dry end of the ARTRV2 Series bluebunch wheatgrass, Utah mountain snowberry, and creeping Oregon-grape are commonly associated with Vasey big sagebrush. Antelope bitterbrush and arrowleaf balsamroot are less common than in the ARTRP4 Series. At the moist end of the ARTRV2 Series all of these dry site species are absent. They are replaced by more mesic species such as slender wheatgrass (*Elymus trachycaulus*), northwest cinquefoil (*Potentilla gracilis*), Richardson's needlegrass (*Stipa richardsonii*), sticky geranium (*Geranium viscosissimum*), spike trisetum (*Trisetum spicatum*), purple oniongrass (*Melica spectabilis*) and Raynold's sedge (*Carex raynoldsii*).

The ARTRV2 Series includes four plant associations and two subseries. Three of these PNV types are characterized by the drier species listed above and three are characterized by the more mesic species. The drier types are as follows:

Vasey big sagebrush - antelope bitterbrush Subseries	(ARTRV2-PUTR2)
Vasey big sagebrush / Idaho fescue - bluebunch wheatgrass p.a.	(ARTRV2/FEID-ELSP3)
Vasey big sagebrush - mountain snowberry Subseries	(ARTRV2-SYOR2)

Both the ARTRV2-SYOR2 and ARTRV2-PUTR2 Subseries are of limited extent on the Pinedale Ranger District and have highly variable understory composition. Our limited data did not reveal any consistent relationship between understory composition and environmental factors, so these types are not subdivided based on understory species. Therefore, they are named at the subseries level rather than as plant associations. Both subseries occur elsewhere on the Bridger-Teton National Forest. Additional data may allow plant associations to be defined within each subseries.

The following plant associations represent the cool, moist end of the ARTRV2 Series:

Vasey big sagebrush / Richardson's needlegrass p.a.	(ARTRV2/STRI2)
Vasey big sagebrush / slender wheatgrass p.a.	(ARTRV2/ELTR7)
Vasey big sagebrush / spike trisetum p.a.	(ARTRV2/TRSP2)

Idaho fescue usually dominates the understory of all these plant associations, so they are named for codominant species or indicator species.

Subalpine Big Sagebrush Series

The Subalpine big sagebrush (or ARTRS2) series is a major landscape component only in the Union Pass Uplands Subsection (Table 3). It occurs predominantly on colluvium and residuum derived from sedimentary parent materials. The ARTRS2 Series has been observed from 8,800 to 9,800 feet elevation, but it may occur as high as 10,500 feet (Beetle and Johnson 1982). Mean annual precipitation ranges from 26 to 32 inches, with an average of 30 inches. Much of this falls as snow and is subject to loss through sublimation and blowing.

The major species associated with subalpine big sagebrush are the same ones that characterize the cool, moist end of the ARTRV2 Series: slender wheatgrass, northwest cinquefoil, spike trisetum, sticky geranium, purple oniongrass, and Raynold's sedge. Idaho fescue usually dominates the understory throughout the

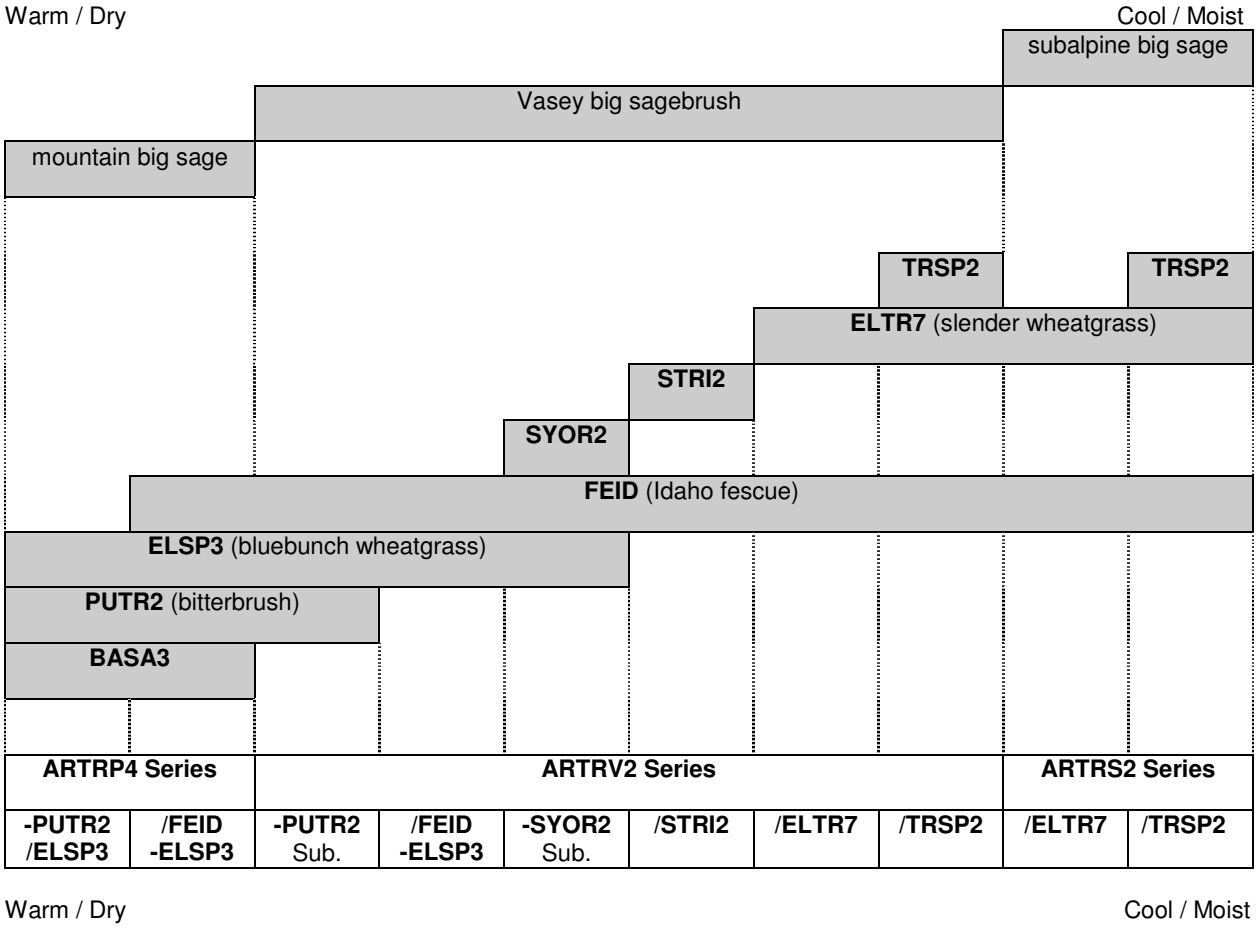


Figure 4. Distribution of big sagebrush PNV types along a temperature-moisture gradient.

ARTRS2 Series. The series has been divided into the following two plant associations based on codominant or indicator species:

Subalpine big sagebrush / slender wheatgrass p.a. (ARTRS2/ELTR7)
Subalpine big sagebrush / spike trisetum p.a. (ARTRS2/TRSP2)

The understories of these associations closely resemble those of the similarly named associations in the ARTRV2 Series.

Relationship of PNV Types to Environmental Factors

Within the Bridger-East EUI survey area mountain, Vasey, and subalpine big sagebrush occur in distinct environments. Mountain big sagebrush occupies the warmest, driest sites and subalpine big sagebrush occupies the coolest, wettest sites. The distribution of associated shrubs and understory species along a temperature-moisture gradient is strongly related to the distribution of big sagebrush taxa. Mountain big sagebrush is associated with a group of dry site species (bluebunch wheatgrass, antelope bitterbrush, arrowleaf balsamroot, and Utah mountain snowberry). Subalpine big sagebrush is associated with a group of more mesic species (slender wheatgrass, spike trisetum, sticky geranium, purple oniongrass, and Raynold's sedge). Vasey big sagebrush is associated with both groups of species. The associated species have been combined with the dominant big sagebrush taxa to define eight plant associations and two subseries. The distribution of these PNV types along a moisture-temperature gradient is shown in figure 4.

Within the range of big sagebrush, the diagnostic plant species used to define plant associations and subseries occur on the landscape wherever environmental conditions allow them to compete successfully with other species. Figure 4 shows where each species occurs with sufficient regularity and abundance to have diagnostic value, not the entire environmental range of each species. The latter is shown in Table 4, which lists the constancy and mean cover of each diagnostic species within each PNV type. The shaded boxes in Table 4 correspond to the species distributions shown in figure 4. The constancy and cover values outside the shaded boxes show the full range of each species along the moisture-temperature gradient. Diagnostic species occur outside the plant associations they characterize, but usually with lower constancy and/or cover than within those associations.

Table 4 is a partial example of a "summary table" (Mueller-Dombois and Ellenberg 1974). Such tables are routinely used to compare and correlate plant community types. This table is presented to validate this PNV classification by comparing the constancy and cover of the diagnostic species between types. Because this is a PNV classification, only late seral stands are included in the table.

The environmental differences between plant associations are smaller than those between series and are often affected by microsite characteristics. Such differences are difficult to portray with the general environmental data collected for an EUI. The arrangement of the plant associations and subseries along a moisture-temperature gradient in figure 4 is based primarily on the obvious environmental differences between the series (i.e. elevation, precipitation, and AWC) and the relationships of the diagnostic species to the big sagebrush taxa. It is also based on differences between PNV types in aspect, slope, and topographic position. In addition, knowledge of the autecology of the diagnostic species has been used to arrange the PNV types along a moisture-temperature gradient. Such knowledge is gained through personal observations of the distribution of plant species and PNV types on the landscape and through literature research.

Even with the above caveats, the environmental data for the PNV types (Table 5, page 12) corresponds reasonably well to the order of the types in figure 4. The exceptions are cases in which two PNV types occur in very similar macroenvironments, but differ in microsite conditions. The ARTRS2/TRSP2 p.a. and the ARTRS2/ELTR7 p.a. are very similar in elevation and mean annual precipitation, but the ARTRS2/TRSP2 p.a. occurs more often on north and east aspects than the ARTRS2/ELTR7 p.a. It also occurs on sites less subject to snow loss through blowing and sublimation than the ARTRS2/ELTR7 p.a. A similar relationship exists between the ARTRV2/TRSP2 p.a. and the ARTRV2/ELTR7 p.a. The ARTRV2-PUTR2 Subseries occurs within the elevation and precipitation ranges of the ARTRV2/FEID-ELSP3 p.a. However, it occurs on steeper slopes, and usually on south aspects.

This classification of big sagebrush PNV types is based on floristics (*i.e.* groups of associated species) and is supported by environmental data collected as part of the EUI process. The arrangement of the PNV types along a moisture-temperature gradient is based on environmental data, floristics, and the autecology of individual diagnostic species.

This PNV classification is a refinement of a preliminary classification reported earlier (Tart 1994). A comparison of these PNV types to the earlier classification is presented in Appendix 5.

Table 4. Distribution of Diagnostic Species Across the Big Sagebrush Pnv Types (Late Seral Plots Only). [1]

	ARTRP4 Series		ARTRV2 Series						ARTRS2 Series	
Diagnostic species:	**-PUTR2 /ELSP3** n=9	**/FEID -ELSP3** n=21	**-PUTR2** Sub. n=2	**/FEID -ELSP3** n=6	**-SYOR2** Sub. n=4	**/STRI2** n=3	**/ELTR7** n=6	**/TRSP2** n=2	**/ELTR7** n=1	**/TRSP2** n=5
subalpine big sagebrush	-	-	-	-	25 1	-	-	-	100 37	100 22
Vasey big sagebrush	-	-	100 25	100 28	100 22	100 27	100 29	100 28	-	40 8
mountain big sagebrush	100 21	100 21	50 5	33 3	25 Tr	-	-	-	-	-
Raynold's sedge	-	-	-	-	-	-	17 Tr	50 1	-	60 2
spike trisetum	-	-	-	-	25 Tr	-	17 Tr	50 1	-	80 3
purple oniongrass	-	-	-	-	25 Tr	-	-	50 1	-	60 2
sticky geranium	-	10 Tr	-	33 1	50 1	33 Tr	-	100 9	-	80 8
slender wheatgrass	-	5 Tr	-	-	50 6	-	83 5	100 4	100 10	100 15
northwest cinquefoil	-	5 Tr	-	50 Tr	50 2	-	83 1	100 5	100 1	100 1
Richardson's needlegrass	-	-	-	-	-	100 23	17 1	-	-	-
Utah mountain snowberry	56 1	71 1	-	17 Tr	100 9	-	-	50 Tr	-	-
Idaho fescue	56 2	100 15	100 23	100 33	75 25	100 20	100 38	100 38	100 40	100 29
bluebunch wheatgrass	100 29	100 20	50 4	83 13	75 25	-	-	-	-	-
antelope bitterbrush	78 11	67 10	100 13	-	-	-	-	-	-	-
arrowleaf balsamroot	78 7	81 5	-	-	100 3	-	-	-	-	-

1. Values are constancy and mean cover. Constancy is the percentage of sample plots in which a species was present. Mean cover is the average percent canopy cover, calculated only across the plots in which the species occurred. Values in shaded boxes indicate species used to characterize PNV types.

Table 5. Mean Environmental Parameters and AWC for Big Sagebrush PNV Types.

PNV Type	Sample Size	Elevation (feet)	Precip. (in.)	Slope (%)	Sample Size	AWC to 40 inches (inches of water)
ARTRS2/TRSP2 p.a.	17	9,247	29	17	13	3.1
/ELTR7 p.a.	21	9,314	30	15	12	3.8
ARTRV2/TRSP2 p.a.	21	8,552	26	13	9	4.0
/ELTR7 p.a.	100	8,574	25	13	31	4.1
/STRI2 p.a.	7	8,067	24	11	4	2.6
-SYOR2 Subseries	14	8,321	23	23	8	3.8
/FEID-ELSP3 p.a.	56	8,181	21	12	21	3.8
-PUTR2 Subseries	7	8,343	21	23	3	2.5
ARTRP4/FEID-ELSP3 p.a.	189	8,301	18	13	51	2.4
-PUTR2/ELSP3 p.a.	66	8,086	15	31	6	2.6

Keys to *Artemisia tridentata* PNV Types

Two keys to big sagebrush plant associations and subseries are included with this guide: a floristic key and a biophysical key. The floristic key is based solely on species composition and is intended primarily for undisturbed stands. It closely reflects the criteria used to define the plant associations and subseries.

The biophysical key uses both floristic and environmental criteria to identify the PNV types, and is therefore more suitable for identifying the potential natural vegetation of disturbed stands. The environmental criteria used are the subsection in which the stand is located, mean annual precipitation, percent slope, and parent material. Mean annual precipitation should be estimated by determining the location and elevation of the stand and using the information in Appendix 4.

The floristic key requires that the subtaxa of big sagebrush in the stand be identified in order to key out the plant association. The biophysical key does not always require that the subtaxa be identified. This is because the subtaxa can often be inferred from the associated understory species, the mean annual precipitation, and the subsection in which the stand is located.

Before using either key a plot should be located in a representative area and sampled using the methods described in Appendix 3. Neither key is infallible. After keying out a plot compare it to the plant association or subseries description to see how well it matches the species composition and environmental setting of the PNV type. If the plot does not match the description, try keying it out again or observe adjacent areas to determine if the plot is truly representative.

Floristic Key

1a. *Artemisia tridentata* ssp. *spiciformis* cover 5% or more……7

1b. *Artemisia tridentata* ssp. *spiciformis* less than 5% cover……2

2a. *Artemisia tridentata* ssp. *spiciformis* potentially 5% cover or more……..7

2b. *Artemisia tridentata* ssp. *spiciformis* naturally less than 5% cover……...3

3a. *Artemisia tridentata* var. *vaseyana* cover 5% or more……..9

3b. *Artemisia tridentata* var. *vaseyana* less than 5% cover……4

4a. *Artemisia tridentata* var. *vaseyana* potentially 5% cover or more……9

4b. *Artemisia tridentata* var. *vaseyana* naturally less than 5% cover……5

5a. *Artemisia tridentata* var. *pauciflora* cover 5% or more……18

5b. *Artemisia tridentata* var. *pauciflora* less than 5% cover……6

6a. *Artemisia tridentata* var. *pauciflora* present……18

6b. *Artemisia tridentata* var. *pauciflora* absent……Use Biophysical Key

***Artemisia tridentata* ssp. *spiciformis* Series**

7a. *Trisetum spicatum, Geranium viscosissimum, Carex raynoldsii*, and *Melica spectabilis* total 5% cover or more .....**A. t. ssp. spiciformis** / **Trisetum spicatum** (p.70)

7b. *Trisetum spicatum, Geranium viscosissimum, Carex raynoldsii*, and *Melica spectabilis* total less than 5% cover 8

8a. *Elymus trachycaulus* and *Potentilla gracilis* total 5% cover or more .....**A. t. ssp. spiciformis** / **Elymus trachycaulus** (p.65)

8b. *Elymus trachycaulus* and *Potentilla gracilis* total less than 5% cover .....Unclassified

***Artemisia tridentata* var. *vaseyana* Series**

9a. *Trisetum spicatum, Geranium viscosissimum, Carex raynoldsii*, and *Melica spectabilis* total 5% cover or more .....**A. t. var. vaseyana** / **Trisetum spicatum** (p.60)

9b. *Trisetum spicatum, Geranium viscosissimum, Carex raynoldsii*, and *Melica spectabilis* total less than 5% cover 10

10a. *Stipa richardsonii* cover 5% or more .....**A. t. var. vaseyana** / **Stipa richardsonii** (p.50)

10b. *Stipa richardsonii* less than 5% cover 11

11a. *Symphoricarpos oreophilus* cover 5% or more .....**A. t. var. vaseyana - Symphoricarpos oreophilus** (p.45)

11b. *Symphoricarpos oreophilus* less than 5% cover 12

12a. *Elymus trachycaulus* and *Potentilla gracilis* total 5% cover or more .....**A. t. var. vaseyana** / **Elymus trachycaulus** (p.55)

12b. *Elymus trachycaulus* and *Potentilla gracilis* total less than 5% cover 13

13a. *Purshia tridentata* present .....**A. t. var. vaseyana - Purshia tridentata** (p.35)

13b. *Purshia tridentata* absent 14

14a. *Elymus spicatus* present 15

14b. *Elymus spicatus* absent 16

15a. *Elymus trachycaulus* and *Potentilla gracilis* total less than 5% cover due to past disturbance .....**A. t. var. vaseyana** / **Elymus trachycaulus** (p.55)

15b. *Elymus trachycaulus* and *Potentilla gracilis* naturally absent or restricted to favored microsites .....**A. t. var. vaseyana** / **Festuca idahoensis - Elymus spicatus** (p.40)

16a. *Carex filifolia* and *Danthonia intermedia* total 5% cover or more .....**A. t. var. vaseyana** / **Elymus trachycaulus** (p.55)

16b. *Carex filifolia* and *Danthonia intermedia* total less than 5% cover 17

17a. *Elymus spicatus* absent due to past disturbance ……**A. t. var. vaseyana** / **Festuca idahoensis - Elymus spicatus** (p.40)

17b. *Elymus spicatus* naturally absent ……..Unclassified

***Artemisia tridentata* var. *pauciflora* Series**

18a. *Festuca idahoensis* more than 5% cover ……**A. t. var. pauciflora** / **Festuca idahoensis - Elymus spicatus** (p.29)

18b. *Festuca idahoensis* cover 5% or less ……19

19a. *Festuca idahoensis* less than 5% cover due to past disturbance ……..**A. t. var. pauciflora** / **Festuca idahoensis - Elymus spicatus** (p.29)

19b. *Festuca idahoensis* naturally absent or restricted to favored microsites ……20

20a. *Purshia tridentata* and *Balsamorhiza sagittata* total 5% cover or more ……..**A. t. var. pauciflora - Purshia tridentata** / **Elymus spicatus** (p.24)

20b. *Purshia tridentata* and *Balsamorhiza sagittata* total less than 5% cover ……21

21a. *Purshia tridentata* and *Balsamorhiza sagittata* total less than 5% cover due to past disturbance ……..**A. t. var. pauciflora - Purshia tridentata** / **Elymus spicatus** (p.24)

21b. *Purshia tridentata* and *Balsamorhiza sagittata* naturally absent or less than 5% cover ……..Unclassified

Biophysical Key

1a. Stand located in the Union Pass Uplands Subsection ……5

1b. Stand not in the Union Pass Uplands Subsection ……2

2a. Stand located in the Subsummit Uplands Subsection ……22

2b. Stand not in the Subsummit Uplands Subsection ……3

3a. Stand located in the Upper Green River Basin Subsection ……22

3b. Stand not in the Upper Green River Basin Subsection ……4

4a. Stand located in the Southeastern Wind River Mountains Subsection ……46

4b. Stand not in the Southeastern Wind River Mountains Subsection ……Use Floristic Key

Union Pass Uplands Subsection

5a. *Trisetum spicatum*,*Geranium viscosissimum*, *Carex raynoldsii*, and *Melica spectabilis* total 5% cover or more ……6

5b. *Trisetum spicatum*, *Geranium viscosissimum*, *Carex raynoldsii*, and *Melica spectabilis* total less than 5% cover ……9

6a. Big sagebrush taxa identified ……7

6b. Big sagebrush taxa not identified ……8

7a. *Artemisia tridentata* ssp. *spiciformis* cover 5% or more ……**A. t. ssp. spiciformis** / **Trisetum spicatum** (p.70)

7b. *Artemisia tridentata* ssp. *spiciformis* cover less than 5% ……**A. t. var. vaseyana** / **Trisetum spicatum** (p.60)

8a. Mean annual precipitation 29 inches or more……**A. t. ssp. spiciformis** / **Trisetum spicatum** (p.70)

8b. Mean annual precipitation less than 29 inches ……**A. t. var. vaseyana** / **Trisetum spicatum** (p.60)

9a. *Stipa richardsonii* cover 5% or more ……**A. t. var. vaseyana** / **Stipa richardsonii** (p.50)

9b. *Stipa richardsonii* cover less than 5% ……10

10a. *Symphoricarpos oreophilus* cover 5% or more ……**A. t. var. vaseyana - Symphoricarpos oreophilus** (p.45)

10b. *Symphoricarpos oreophilus* cover less than 5% ……11

11a. *Elymus trachycaulus* and *Potentilla gracilis* total 5% cover or more ……12

11b. *Elymus trachycaulus* and *Potentilla gracilis* total less than 5% cover ……16

12a. Big sagebrush taxa identified ……13

12b. Big sagebrush taxa not identified ……14

13a. *Artemisia tridentata* ssp. *spiciformis* cover 5% or more ……**A. t. ssp. spiciformis** / **Elymus trachycaulus** (p.65)

13b. *Artemisia tridentata* ssp. *spiciformis* cover less than 5% ……**A. t. var. vaseyana** / **Elymus trachycaulus** (p.55)

14a. Mean annual precipitation 30 inches or more ……**A. t. ssp. spiciformis** / **Elymus trachycaulus** (p.65)

14b. Mean annual precipitation less than 30 inches ……15

15a. Mean annual precipitation 28 inches or less ……**A. t. var. vaseyana** / **Elymus trachycaulus** (p.55)

15b. Mean annual precipitation equals 29 inches ……Cannot be identified

16a. *Purshia tridentata* present ……**A. t. var. vaseyana - Purshia tridentata** (p.35)

16b. *Purshia tridentata* absent ……17

17a. *Elymus spicatus* present ……18

17b. *Elymus spicatus* absent ……21

18a. Mean annual precipitation 24 inches or less ……**A. t. var. vaseyana** / **Festuca idahoensis - Elymus spicatus** (p.40)

18b. Mean annual precipitation more than 24 inches ……19

19a. Mean annual precipitation 27 inches or more ……**A. t. var. vaseyana** / **Elymus trachycaulus** (p.55)

19b. Mean annual precipitation less than 27 inches ……20

20a. *Elymus trachycaulus* and *Potentilla gracilis* total less than 5% cover due to past disturbance ……**A. t. var. vaseyana** / **Elymus trachycaulus** (p.55)

20b. *Elymus trachycaulus* and *Potentilla gracilis* naturally absent or restricted to favored microsites ……**A. t. var. vaseyana** / **Festuca idahoensis - Elymus spicatus** (p.40)

21a. *Carex filifolia* and *Danthonia intermedia* total 5% cover or more ……12

21b. *Carex filifolia* and *Danthonia intermedia* total less than 5%cover ……18

Subsummit Uplands and Upper Green River Basin Subsections

22a. *Trisetum spicatum, Geranium viscosissimum, Carex raynoldsii*, and *Melica spectabilis* total 5% cover or more ……23

22b. *Trisetum spicatum, Geranium viscosissimum, Carex raynoldsii*, and *Melica spectabilis* total less than 5% cover ……26

23a. Big sagebrush taxa identified ……24

23b. Big sagebrush taxa not identified ……25

24a. *Artemisia tridentata* ssp. *spiciformis* cover 5% or more .....**A. t. ssp. spiciformis** / **Trisetum spicatum** (p.70)

24a. *Artemisia tridentata* ssp. *spiciformis* less than 5% cover .....**A. t. var. vaseyana** / **Trisetum spicatum** (p.60)

25a. Mean annual precipitation 30 inches or more .....**A. t. ssp. spiciformis** / **Trisetum spicatum** (p.70)

25b. Mean annual precipitation less than 30 inches .....**A. t. var. vaseyana** / **Trisetum spicatum** (p.60)

26a. *Symphoricarpos oreophilus* cover 5% or more .....**A. t. var. vaseyana - Symphoricarpos oreophilus** (p.45)

26b. *Symphoricarpos oreophilus* cover less than 5% 27

27a. *Elymus trachycaulus* and *Potentilla gracilis* total 5% cover or more 28

27b. *Elymus trachycaulus* and *Potentilla gracilis* total less than 5% cover 31

28a. Big sagebrush taxa identified 29

28b. Big sagebrush taxa not identified 30

29a. *Artemisia tridentata* ssp. *spiciformis* cover 5% or more .....**A. t. ssp. spiciformis** /**Elymus trachycaulus** (p.65)

29a. *Artemisia tridentata* ssp. *spiciformis* less than 5% cover .....**A. t. var. vaseyana** /**Elymus trachycaulus** (p.55)

30a. Mean annual precipitation 30 inches or more .....**A. t. ssp. spiciformis** /**Elymus trachycaulus** (p.65)

30b. Mean annual precipitation less than 30 inches .....**A. t. var. vaseyana** /**Elymus trachycaulus** (p.55)

31a. *Purshia tridentata* present 32

31b. *Purshia tridentata* absent 41

32a. Big sagebrush taxa identified 33

32b. Big sagebrush taxa not identified 39

33a. *Artemisia tridentata* var. *vaseyana* cover 5% or more .....**A. t. var. vaseyana - Purshia tridentata** (p.35)

33b. *Artemisia tridentata* var. *vaseyana* less than 5% cover 30

34a. *Festuca idahoensis* more than 5% cover .....**A. t. var. pauciflora** / **Festuca idahoensis - Elymus spicatus** (p.29)

34b. *Festuca idahoensis* cover 5% or less 35

35a. Mean annual precipitation 15 inches or less 36

35b. Mean annual precipitation more than 15 inches 38

36a. Slope greater than 10 percent ……**A. t. var. pauciflora - Purshia tridentata / Elymus spicatus** (p.24)

36b. Slope 10 percent or less ……..37

37a. *Festuca idahoensis* less than 5% cover due to past disturbance ……..**A. t. var. pauciflora** / **Festuca idahoensis - Elymus spicatus** (p.29)

37b. *Festuca idahoensis* naturally absent or restricted to favored microsites …….**A. t. var. pauciflora - Purshia tridentata / Elymus spicatus** (p.24)

38a. Slope greater than 20 percent ……**A. t. var. pauciflora - Purshia tridentata / Elymus spicatus** (p.24)

38a. Slope 20 percent or less ……..37

39a. Mean annual precipitation less than 20 inches ……..34

39b. Mean annual precipitation 20 inches or more ……..40

40a. Parent material is all granitic or metamorphic rocks ……..34

40b. Parent material includes at least some sedimentary rocks ……...Cannot be identified

41a. Big sagebrush taxa identified ……..42

41b. Big sagebrush taxa not identified ……..44

42a. *Artemisia tridentata* var. *vaseyana* cover 5% or more……..43

42b. *Artemisia tridentata* var. *vaseyana* cover less than 5% ……..34

43a. *Elymus trachycaulus* and *Potentilla gracilis* total less than 5% cover due to past disturbance ……..**A. t. var. vaseyana** /**Elymus trachycaulus** (p.55)

43b. *Elymus trachycaulus* and *Potentilla gracilis* naturally absent or restricted to favored microsites ……...**A. t. var. vaseyana** / **Festuca idahoensis - Elymus spicatus** (p.40)

44a. Mean annual precipitation 24 inches or more ……..43

44b. Mean annual precipitation less than 24 inches ……..45

45a. Mean annual precipitation less than 14 inches ……..34

45b. Mean annual precipitation 14 inches or more ……...Cannot be identified

Southeastern Wind River Mountains Subsection

46a. *Trisetum spicatum, Geranium viscosissimum, Carex raynoldsii*, and *Melica spectabilis* total 5% cover or more 47

46b. *Trisetum spicatum, Geranium viscosissimum, Carex raynoldsii*, and *Melica spectabilis* total less than 5% cover 51

47a. Big sagebrush taxa identified 48

47b. Big sagebrush taxa not identified 49

48a. *Artemisia tridentata* ssp. *spiciformis* cover 5% or more .....**A. t. ssp. spiciformis** / **Trisetum spicatum** (p.70)

48b. *Artemisia tridentata* ssp. *spiciformis* cover less than 5% .....**A. t. var. vaseyana** / **Trisetum spicatum** (p.60)

49a. Mean annual precipitation 28 inches or more .....**A. t. ssp. spiciformis** / **Trisetum spicatum** (p.70)

49b. Mean annual precipitation less than 28 inches 50

50a. Mean annual precipitation 25 inches or less .....**A. t. var. vaseyana** / **Trisetum spicatum** (p.60)

50b. Mean annual precipitation more than 25 inches .....Cannot be identified

51a. *Elymus trachycaulus* and *Potentilla gracilis* total 5% cover or more 52

51b. *Elymus trachycaulus* and *Potentilla gracilis* total less than 5% cover 56

52a. Big sagebrush taxa identified 53

52b. Big sagebrush taxa not identified 54

53a. *Artemisia tridentata* ssp. *spiciformis* cover 5% or more .....**A. t. ssp. spiciformis** / **Elymus trachycaulus** (p.65)

53b. *Artemisia tridentata* ssp. *spiciformis* cover less than 5% .....**A. t. var. vaseyana** / **Elymus trachycaulus** (p.55)

54a. Mean annual precipitation 28 inches or more .....**A. t. ssp. spiciformis** / **Elymus trachycaulus** (p.65)

54b. Mean annual precipitation less than 28 inches 55

55a. Mean annual precipitation 25 inches or less .....**A. t. var. vaseyana** / **Elymus trachycaulus** (p.55)

55b. Mean annual precipitation more than 25 inches .....Cannot be identified

56a. *Purshia tridentata* present 57

56b. *Purshia tridentata* absent 65

57a. Big sagebrush taxa identified 58

57b. Big sagebrush taxa not identified 64

58a. *Artemisia tridentata* var. *vaseyana* cover 5% or more ..... **A. t. var. vaseyana - Purshia tridentata** (p.35)

58b. *Artemisia tridentata* var. *vaseyana* cover less than 5% cover 59

59a. *Festuca idahoensis* more than 5% cover ..... **A. t. var. pauciflora** / **Festuca idahoensis - Elymus spicatus** (p.29)

59b. *Festuca idahoensis* cover 5% or less 60

60a. Mean annual precipitation 18 inches or less 61

60b. Mean annual precipitation more than 18 inches 63

61a. Slope greater than 10 percent ..... **A. t. var. pauciflora - Purshia tridentata / Elymus spicatus** (p.24)

61b. Slope 10 percent or less 62

62a. *Festuca idahoensis* less than 5% cover due to past disturbance ..... **A. t. var. pauciflora** / **Festuca idahoensis - Elymus spicatus** (p.29)

62b. *Festuca idahoensis* naturally absent or restricted to favored microsites ..... **A. t. var. pauciflora - Purshia tridentata / Elymus spicatus** (p.24)

63a. Slope 25 percent or more ..... **A. t. var. pauciflora - Purshia tridentata / Elymus spicatus** (p.24)

63b. Slope less than 25 percent 62

64a. Mean annual precipitation 18 inches or less 59

64b. Mean annual precipitation more than 18 inches ..... Cannot be identified

65a. Big sagebrush taxa identified 66

65b. Big sagebrush taxa not identified 68

66a. *Artemisia tridentata* var. *vaseyana* cover 5% or more 67

66b. *Artemisia tridentata* var. *vaseyana* cover less than 5% 59

67a. *Elymus trachycaulus* and *Potentilla gracilis* total less than 5% cover due to past disturbance ..... **A. t. var. vaseyana** / **Elymus trachycaulus** (p.55)

67b. *Elymus trachycaulus* and *Potentilla gracilis* naturally absent or restricted to favored microsites ..... **A. t. var. vaseyana** / **Festuca idahoensis - Elymus spicatus** (p.40)

68a. Mean annual precipitation 25 inches or more 67

68b. Mean annual precipitation less than 25 inches 69

69a. Mean annual precipitation less than 20 inches 59

69b. Mean annual precipitation 20 inches or more ..... Cannot be identified

Plant Association and Subseries Descriptions

A plant association or subseries description includes the biotic and physical characteristics of the type, its geographic distribution, successional relationships, associated vegetation types, and management implications. Each description also includes a comparison to similar PNV types described elsewhere and a cross reference to the Bridger-East EUI. The following outline lists the contents of each section of a PNV type description.

Distribution and Extent

This section describes the geographic distribution of the type (including a map). It also lists the geographic and areal extent of the PNV type by subsection. The **geographic extent** is the total acreage of EUI map units in which the PNV type is a component. The **areal extent** is the acreage within the geographic extent actually occupied by the type. EUI map units usually have more the one component, so the areal extent is always smaller than the geographic extent.

Environment

This section describes the physical environment of the PNV type. This includes the predominant landforms and geologic parent materials on which it occurs and elevation, annual precipitation, slope, and aspect. For definitions of landform and geologic terms see the Bridger-East EUI report. Elevation, precipitation, and slope are presented as a mean and an observed range based on both EUI plot data and range analysis data on file at the Pinedale Ranger District. Annual precipitation was estimated for each plot using the method described in Appendix 4. Where these parameters differ significantly between subsection, the mean values for each subsection are also given.

Vegetation

This section includes **diagnostic species** (*i.e* species used to identify the PNV type), the major shrubs and herbs occurring in the type, total annual production, and species richness. **Total annual production** is taken from range analysis data collected between 1960 and 1983. The range analysis transects were keyed out using the keys in this report, then the production data compiled for each PNV type. A “typical range” refers to the middle 80 percent of the production values. **Species richness** refers to the number of species (or plant taxa) occurring on a plot. The mean and range across all plots in the type are given as well as the mean for late seral plots.

Plant Community Composition Table

This table lists the constancy and mean canopy cover of the major species by seral stage and the ecological role of each species. **Seral stage** describes how far away a stand is from PNV or climax conditions. Late seral stands are close to PNV, early seral stands are far from PNV, and mid seral stands are in between. Many climax species tend to decrease with man-caused disturbance. Seral stage is based on the amount of these decreaser species present in the understory *versus* the amount of species that increase on bared soil. The **ecological role** column of the table lists each species’ response to disturbance (if known) and its relative importance in the climax community. It also identifies species that are restricted to specialized microsites or indicated transition toward another PNV type. The table also identifies diagnostic and character species for the type. A **character species** is not used to key out the type, but is usually present and can be used to confirm the identity of a stand after keying it out.

Soils

This section described the predominant soil types on which the PNV type occurs, including soil differences between subsections where applicable. Mean values of soil properties important to plant growth are given, based on the soil descriptions of the Bridger-East EUI. These properties are depth to a restrictive layer, rooting depth, AWC to 40 inches (or a restrictive layer), and AWC to the rooting depth. Other properties important in the taxonomic classification of soils are listed by the percentage of the PNV types areal extent in which those properties occur. These properties include depth to a restrictive layer, particle size class (i.e. soil texture and rock content), drainage class, and the presence or absence of a layer of clay accumulation. The areal extent of these properties is based on the mapping of ecological types by the Bridger-East EUI. The soil families on which the PNV type most commonly occurs are also listed.

Definitions of soil terms are available in the Bridger-East EUI report and the *Soil Survey Manual* (USDA 1993).

Associated Vegetation

This section lists the other PNV types found in association with the type on the landscape, based on the ecological unit mapping of the Bridger-East EUI. This list also includes the acreage over which the types occur together as major components of an ecological map unit.

Seral Stages

This section compares the seral stages of the PNV type in terms of canopy cover, ground cover, and environmental parameters. Comparing canopy cover and ground cover allow the effects of disturbance to be described. Canopy cover is given by life form (shrubs, graminoids, forbs) as recorded on the EUI plots. Total canopy cover was not recorded in the field, so cover sum is given *in lieu* of it. The **cover sum** is the total of the individual canopy cover of all species on a plot. Because species often overlap one another the cover sum is usually greater than the total canopy cover. (It can also be greater than 100 percent.) Ground cover is divided into basal vegetation, litter and wood, moss and lichen, rock, and bare soil.

Environmental parameters (elevation, precipitation, slope, and aspect) are compared to test the validity of the seral stages and the PNV type classification itself. Major differences in elevation, precipitation, and/or aspect would suggest that the “stages” actually represent different PNV types. Slope often indicates accessibility to grazing animals and can corroborate the assignment of stands to a particular seral stage.

Management Implications

This section discusses management opportunites and limitations of the PNV type. The topics addressed are reponse of the type to fire (and fire suppression), suitablity for big game habitat, suitability for livestock grazing, plant community responses to grazing, revegetation, and watershed protection.

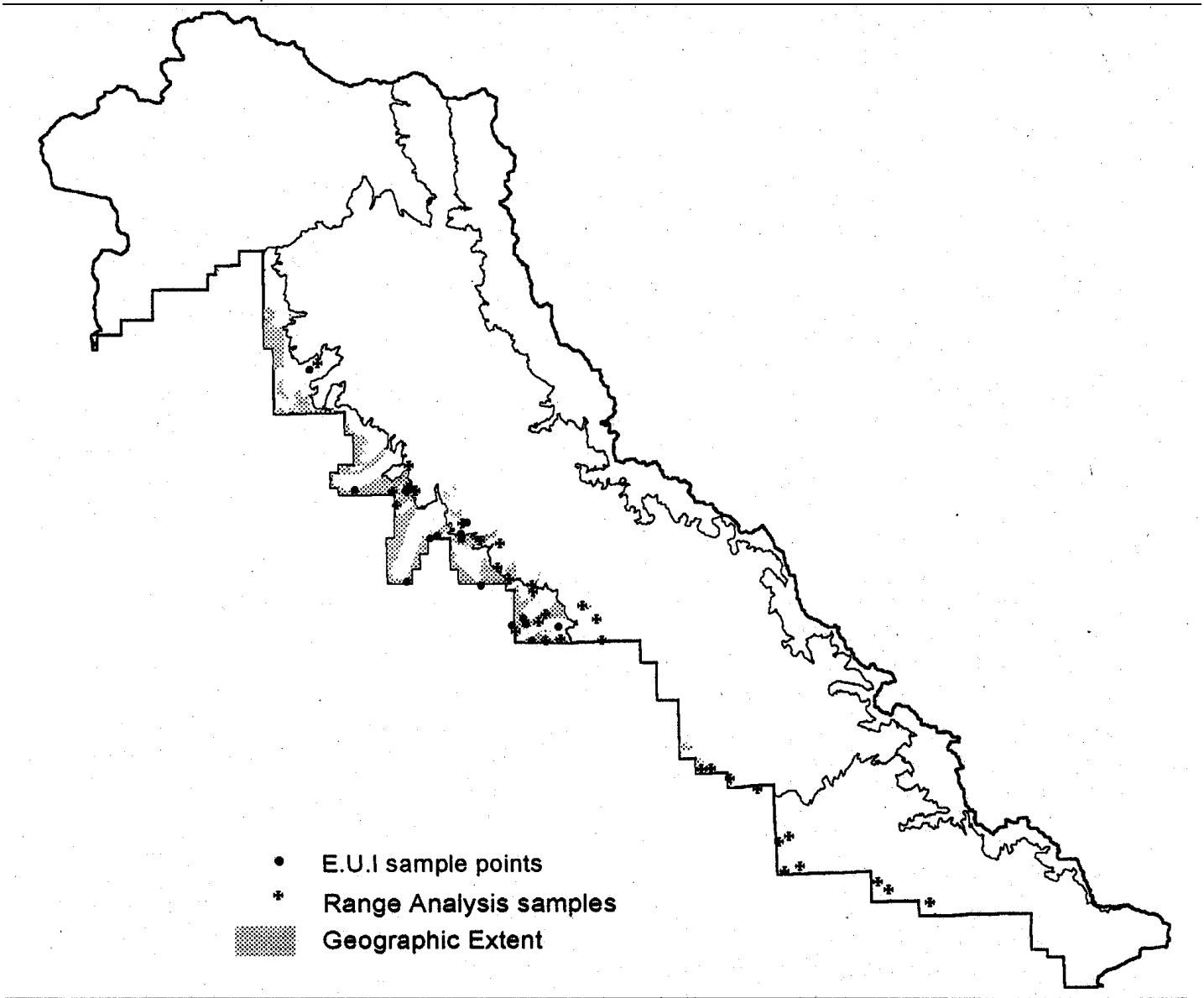
Comparison to Other Studies

This section compares the PNV type to other types described in adjacent areas. This serves to correlate this PNV classification with previous classification, pointing out similarities and differences. Hopefully, this allows users of this report to properly extrapolate management experience in other geographic areas to this area without mixing apples and oranges.

E.U.I. Cross Reference

This section lists the ecological types from the Bridger-East EUI characterized by the PNV type and the ecological map units in which those ecological types occur as a major component. This facilitates access to more detailed soil information in the EUI report and database.

Mountain big sagebrush - Antelope bitterbrush / bluebunch wheatgrass Plant Association
Artemisia tridentata var. ***pauciflora - Purshia tridentata / Elymus spicatus*** p.a.
ARTRP4-PUTR2/ELSP3 p.a.



DISTRIBUTION AND EXTENT

The ARTRP4-PUTR2/ELSP3 p.a. occurs as a major landscape component from McDowell Flat to the Aspen Butte area in the Upper Green River Basin and Subsummit Uplands subsections. It also occurs in minor amounts from Muddy Lake to Block and Tackle Hill in the Southeastern Wind River Mountains subsection. It has a geographic extent of about 20,100 acres and occupies about 7,300 acres within that area. The following table lists the geographic and areal extent of this plant association within each subsection.

Subsection	Geographic Extent	Areal Extent
Upper Green River Basin	17,900ac	6,400ac
Subsummit Uplands	2,200ac	900ac

ENVIRONMENT

This is the warmest and driest big sagebrush plant association on the Pinedale Ranger District.

Landforms: Sideslopes and summits of glacial moraines and till-mantled slopes, and backslopes of non-glaciated mountain slopes.

Parent materials: Glacial till, residuum, or colluvium dominated by granitic materials.

n=66	Mean	Observed Range
Elevation (ft)	8086	7300 - 8880
Annual Precip. (in)	15	11 - 23
Slope (%)	31	5 - 75

Aspect: Predominantly south.

VEGETATION

Diagnostic Species: The ARTRP4-PUTR2/ELSP3 p.a. includes communities in which mountain big sagebrush cover is at least 5 percent, and antelope bitterbrush and arrowleaf balsamroot total at least 5 percent cover. Idaho fescue, when present, is restricted to moist microsites with cover of 5 percent or less.

Shrubs: Mountain big sagebrush is dominant and forms a low to medium shrub layer 1 to 3 feet tall. Antelope bitterbrush cover is highly variable, but it is often a codominant shrub in this plant association. Creeping Oregon-grape, green rabbitbrush, and Utah mountain snowberry are often present in small amounts.

Herbs: Bluebunch wheatgrass dominates the herb layer. Needle-and-thread, arrowleaf balsamroot, pussytoes, hawksbeard, longleaf phlox, sulphur buckwheat, and Indian paintbrush are often present.

Production: Total annual production (current year's growth of shrubs and herbs) averaged 560 lbs/acre on 38 range analysis transects, with a typical range of 270 to 800 lbs/acre. This range reflects variation in environmental factors and annual climatic variation as well as the effects of disturbance. These transects were sampled between 1960 and 1982. They are on file at the Pinedale Ranger District.

Species Richness: The number of plant taxa per plot ($375m^2$) ranged from 12 to 35, with a mean of 22 across all seral stages. Late seral plots averaged 18 taxa present. This plant association ranked ninth out of ten in species richness.

SOILS

Only six soil pedons have been described in this plant association. All of them are deep, well drained soils with a loamy-skeletal subsoil layer. The surface texture ranges from gravelly sandy loam to very bouldery sandy loam. None of the pedons had a layer of clay accumulation (*i.e.* argillic horizon).

The table below lists the mean values for properties closely related to plant growth.

n = 6	Mean	Range
Depth to Restrictive Layer (in)	54+	40 - 60+
Rooting Depth (in)	34	26 - 47
A.W.C. to 40 inches (in)	2.6	2.0 - 2.9
A.W.C. to rooting depth (in)	2.3	1.6 - 3.0

This plant association has been observed on the following soil families:

Loamy-skeletal, mixed, Pachic Cryoborolls
Loamy-skeletal, mixed, Typic Cryoborolls

Pachic Cryoborolls appear to be much more common than Typic Cryoborolls in this plant association.

ASSOCIATED VEGETATION

Within the Bridger-East EUI survey area, the ARTRP4-PUTR2/ELSP3 p.a. occurs in association with the ARTRP4 /FEID-ELSP3 p.a. and aspen communities. The table below lists the PNV types that occur as major landscape components within the geographic extent of the ARTRP4-PUTR2/ELSP3 p.a. and the area over which each PNV type is also a component.

Associated PNV	Acres in Association	Percent Co-occurrence
ARTRP4/FEID-ELSP3 p.a.	16,280	35%
POTR5/SYOR2/BRCA5 c.t.	13,430	29%
POTR5/THFE c.t.	5,430	12%

SERAL STAGES

Seral stage is based on canopy cover of understory decreasers and increasers; it is not directly related to sagebrush cover. The following table compares the seral stages of this association in terms of canopy cover, ground cover, and environmental features. Environmental conditions are similar across seral stages. The table indicates that the major effects of disturbance on this plant association include decreases in grass cover, shrub cover, and total canopy cover. Litter also decreases, but cryptogram cover increases so there is little change in the amount of bare soil.

	Late n=9	Mid n=9	Early n=10
Canopy Cover:			
Shrubs	29	33	20
Graminoids	37	28	26
Forbs	12	8	16
Cover Sum	83	74	65
Ground Cover:			
Basal Vegetation	8	8	6
Litter & Wood	54	56	48
Moss & Lichen	2	1	8
Rock	23	17	22
Bare Soil	13	18	16
Environment:			
Slope (%)	28	28	22
Precipitation (in)	14	13	14
Elevation (ft)	8028	7804	7943
Aspect	S,W,E	S,E,N	S,W

ARTRP4-PUTR2/ELSP3 p.a. Plant Community Composition (n=28)

		Late Seral[1] n = 9		Mid Seral n = 9		Early Seral n = 10		
Common Name	Code	Const	Cover	Const	Cover	Const	Cover	Ecological Role
Shrubs:								
mountain big sagebrush	ARTRP4 **	100	21	100	26	100	17	Major climax increaser
antelope bitterbrush	PUTR2 **	78	11	100	7	80	2	Major climax decreaser
creeping Oregon-grape	BERE	67	1	33	1	60	1	Minor climax, rocky sites
Utah mountain snowberry	SYORU	56	1	100	1	50	1	Minor climax increaser
green rabbitbrush	CHVI8	56	Tr	100	1	50	1	Minor climax increaser
spiny phlox	LEPU	11	1	11	Tr	20	2	Minor climax increaser
Perennial Grasses:								
bluebunch wheatgrass	ELSP3 **	100	29	100	19	100	8	Major climax decreaser
needle-and-thread	STCO4 *	89	2	89	4	90	7	Minor Climax increaser
Columbia needlegrass	STNE3	56	4	22	2	40	8	Minor climax decreaser
Idaho fescue	FEID	56	2	44	3	70	3	Minor climax decreaser
Letterman's needlegrass	STLE4	33	4	22	5	-	-	Minor climax increaser
Sandberg bluegrass	POSES#	33	1	33	3	30	5	Minor climax increaser
Cusick's bluegrass	POCU3	33	1	-	-	20	3	Minor climax decreaser
bluegrass	POA	22	3	33	2	40	1	Minor climax decreaser
mutton bluegrass	POFE	22	1	11	3	10	Tr	Minor climax decreaser
Indian ricegrass	ORHY	11	5	44	1	40	1	Minor climax decreaser
bottlebrush squirreltail	ELEL5	11	Tr	22	1	20	2	Minor climax increaser
Annual Grasses:								
cheatgrass brome	BRTE	11	1	22	2	10	17	Alien increaser
sixweeks fescue	FEOC3	-	-	-	-	10	4	Minor climax increaser
Sedges and Rushes:								
sedge	CAREX	56	1	56	2	70	2	Minor climax increaser
Ross' sedge	CARO5	11	2	22	1	30	1	Minor climax increaser
obtuse sedge	CAOB4	11	1	22	2	10	1	Minor climax increaser
Perennial Forbs:								
arrowleaf balsamroot	BASA3 **	78	7	89	2	80	5	Major climax decreaser
pussytoes	ANTEN	78	1	78	2	90	3	Increases on bared soil
pale bastard toadflax	COUMP2	78	1	56	1	70	1	Minor climax increaser
hawksbeard	CREPI	67	1	44	1	50	1	Minor climax decreaser
sulphur buckwheat	ERUM	67	1	33	2	40	1	Increases on bared soil
longleaf phlox	PHLO2	67	1	33	1	70	1	Minor climax decreaser
Indian paintbrush	CASTI2	67	Tr	44	1	50	3	Minor climax
rockcress	ARABI2	44	Tr	44	Tr	40	Tr	Minor climax
lupine	LUPIN	33	2	11	Tr	50	1	Minor climax increaser
groundsel	SENEC	33	Tr	22	Tr	40	Tr	Minor climax
Mariposa lily	CALOC	33	Tr	11	Tr	50	Tr	Minor climax decreaser
stickseed	HACKE	33	Tr	11	Tr	30	Tr	Minor climax
penstemon	PENST	22	1	33	Tr	40	Tr	Minor climax
western gromwell	LIRU4	22	1	11	Tr	50	1	Minor climax increaser
buckwheat	ERIOG	22	Tr	44	Tr	30	1	Minor climax increaser
milkvetch	ASTRA	22	Tr	11	1	20	2	Minor climax increaser
fleabane	ERIGE2	11	1	22	2	60	1	Minor climax increaser
aster	ASTER	11	Tr	44	Tr	20	1	Minor climax increaser
Annual Forbs:								
knotweed	POLYG4	33	1	55	Tr	40	2	Increases on bared soil
smallflower blue eyed Mary	COPA3	33	1	22	2	20	2	Increases on bared soil
Redowski's tickseed	LARE	33	1	-	-	10	2	Minor climax increaser
catseye	CRYPT	22	2	56	Tr	60	1	Minor climax increaser
groundsmoke	GAYOP	22	1	22	1	60	2	Minor climax increaser

** = Diagnostic species. * = Character species.

1. Seral stage is based on cover of understory decreasers and increasers; it is not directly related to sagebrush cover.

MANAGEMENT IMPLICATIONS

Fire Response: Mountain big sagebrush plant associations have a natural fire frequency between 10 and 30 years (Kauffman 1990; Winward 1991). Presettlement fires burned unevenly leaving islands and stringers of sagebrush unburned during any one fire. Fire intensity varied in the areas that did burn. The result of such fires was an ever changing mosaic of different densities and ages of sagebrush plants, ranging from recently burned, open grasslands to very dense sagebrush stands that had not burned in a long time (Winward 1991).

The seeds of mountain big sagebrush are stimulated to germinate by the heat of a fire (Champlin and Winward 1982; Hironaka *et al*. 1983; Crane and Fischer 1986). After a burn it can recover to 20 percent canopy cover in as little as 12 years (Winward 1991). In the absence of fire mountain big sagebrush continues to increase in density and cover, and may reach canopy cover values as high as 45 percent. If sagebrush canopy cover exceeds 20 percent for a long period of time, the density, cover, and biomass of herbaceous species will be reduced through shading and competition for moisture. Fire suppression over the last 80 years has allowed dense sagebrush canopies to develop over much of the area occupied by this plant association. A 10 to 20 year cycle of sagebrush removal or thinning is needed to maintain natural amounts of grasses and forbs in this plant association (Hironaka *et al*. 1983).

Under the natural fire regime of this plant association, antelope bitterbrush was rejuvenated by fire through either resprouting following cool burns or by seed germination following hot fires (Driver 1983, 1990; Simon 1990). However, years of fire suppression have produced old, and often decadent, bitterbrush plants with little ability to resprout. Simon (1990) found that bitterbrush plants older that 50 years had very little resprouting ability.

Bluebunch wheatgrass can be severely damaged by hot summer fires and by a spring burn, between green up and flowering, when its root reserves are lowest. It can increase following the removal of sagebrush by a cool fire. For best results, a burned area should be rested from grazing for two growing seasons. Early seral stands may not improve even with rest because the depleted understory provides very little competition for new sagebrush seedlings. Under these conditions the understory cannot recover significantly by the time sagebrush canopy cover returns to preburn levels. In such cases shrub density may increase many-fold following a fire (Hironaka *et al*. 1983).

This plant association is warm enough for cheatgrass to survive. So, a hot fire that damages the perennial grasses may result in invasion by cheatgrass. In early seral stands, cheatgrass may invade even after a cool burn because the understory is already depleted.

Big Game Habitat: This plant association provides important foraging areas for elk and deer. It is occasionally utilized by pronghorn antelope and moose. Because it occurs on steep south aspects and contains abundant bitterbrush, this plant association is an important component of elk winter range. Bluebunch wheatgrass is highly preferred by elk and moderately preferred by deer. Antelope bitterbrush is highly preferred by both. Mountain big sagebrush is an important food source for deer and elk in fall and winter, but is rarely used in spring and summer. Any sagebrush removal or thinning should be done in a mosaic pattern to maintain winter browse while increasing herbaceous production.

Livestock Production: This association receives limited livestock use because it occurs mostly on steep slopes. Bluebunch wheatgrass is the principle forage species in this plant association. It is highly preferred by cattle and moderately preferred by sheep. Antelope bitterbrush is highly preferred by both cattle and sheep.

Response to Grazing: Overgrazing will decrease the amounts of bluebunch wheatgrass and bitterbrush. Other common decreasers include Columbia needlegrass, Idaho fescue (in moist microsites), arrowleaf balsamroot, hawksbeard, longleaf phlox, and Cusick's bluegrass. Species that increase with overgrazing include needle-and-thread, Letterman's needlegrass, pussytoes, and Sandberg bluegrass. Overgrazing may also result in invasion by cheatgrass.

Bluebunch wheatgrass is highly susceptible to damage from spring grazing, which depletes its root reserves and prevents it from producing seed. Repeated spring grazing can eliminate it from an area in a few years (USDA Forest Service 1937). To maintain bluebunch wheatgrass, grazing should be deferred until after seed set at least every third year. This may be difficult to do in areas used by wildlife in the spring.

Heavy grazing of understory species can enhance the natural tendency of mountain big sagebrush to increase in density and cover in two ways. First, by reducing competition from grasses and forbs. Second, by reducing fine fuels and thereby reducing the spread of wildfires. This increases the interval between fires and allows sagebrush cover to increase for a longer period of time.

Revegetation: The herbaceous layer of this plant association can be severely reduced by competition from overly dense sagebrush (see Fire Response) and/or improper grazing. Stands with moderately depleted understories may be capable of natural revegetation with appropriate management. However, recovery is likely to be slow on the dry, south-facing sites occupied by this plant association. To promote natural revegetation, management must allow remnant desirable plants to increase in vigor and produce seed, and then allow seedlings to become established. This may require rest from grazing or deferment of grazing until after seed set.

If sagebrush cover is more than 20 percent, then some type of shrub removal will be needed to release the understory from competition (Winward 1991). Chemical or mechanical treatments will usually reduce sagebrush cover for a longer time period than prescribed burning because germination of mountain big sagebrush seeds is stimulated by the heat of a fire. The effect on antelope bitterbrush should also be considered in selecting a shrub removal treatment.

Watershed: In late seral stands of this plant association the canopy cover sum ranges from 72 to 99 percent, with a mean of 83 percent. Bare soil ranges from 5 to 20 percent. So in relatively undisturbed stands most, but not all, of the soil surface is protected from rain drop impact and surface runoff. In early seral stands the cover sum ranges from 42 to 78 percent, with a mean of 65 percent. Bare soil ranges from 8 to 25 percent. Improper grazing and fire both reduce ground cover and expose more of the soil surface to rain drop impact and surface runoff. Stands with more than 20 percent bare soil are at risk of soil loss, which could lower site potential. This risk is greater on steeper slopes.

Much of the precipitation received by this plant association falls as snow and is subject to loss through sublimation and removal by wind. A shrub canopy helps minimize these losses. On the south-facing slopes typical of this plant association shrub removal may increase snow loss and reduce the available moisture on the site. However, total water consumption is lower on sites where sagebrush is removed (Knight 1994). It is possible that dense sagebrush stands produced by fire suppression and overgrazing have reduced deep infiltration, ground water supplies, and stream flows from presettlement levels. The hydrologic effects of sagebrush are more pronounced on deeper soils (Knight 1994).

COMPARISON TO OTHER STUDIES

Most classifications of sagebrush vegetation types have not

taken big sagebrush taxonomy to the variety level, and big sagebrush taxonomy was refined after many of the classifications were done. These factors complicate the comparison of this plant association to other big sagebrush vegetation types.

This plant association is somewhat similar to the "*Artemisia vaseyana* / *Agropyron spicatum*" habitat type (h.t.) described by Hironaka *et al*. (1983) in southern Idaho. That habitat type was named for *Artemisia tridentata* subspecies *vaseyana* but is dominated by variety *pauciflora*. That habitat type is defined by the absence of Idaho fescue and does not always support antelope bitterbrush.

This plant association does not correspond to any big sagebrush habitat type described in western Montana (Mueggler and Stewart 1980) or on the Shoshone Nation Forest (Tweit and Houston 1980).

E.U.I. CROSS REFERENCE

The following ecological types from the Bridger-East EUI are characterized by the ARTRP4-PUTR2/ELSP3 p.a.:

ARTRP4-PUTR2/ELSP3, Blanca Family ET
ARTRP4-PUTR2/ELSP3, Decram Family ET

These ecological types occur as a major component in the following ecological map units:

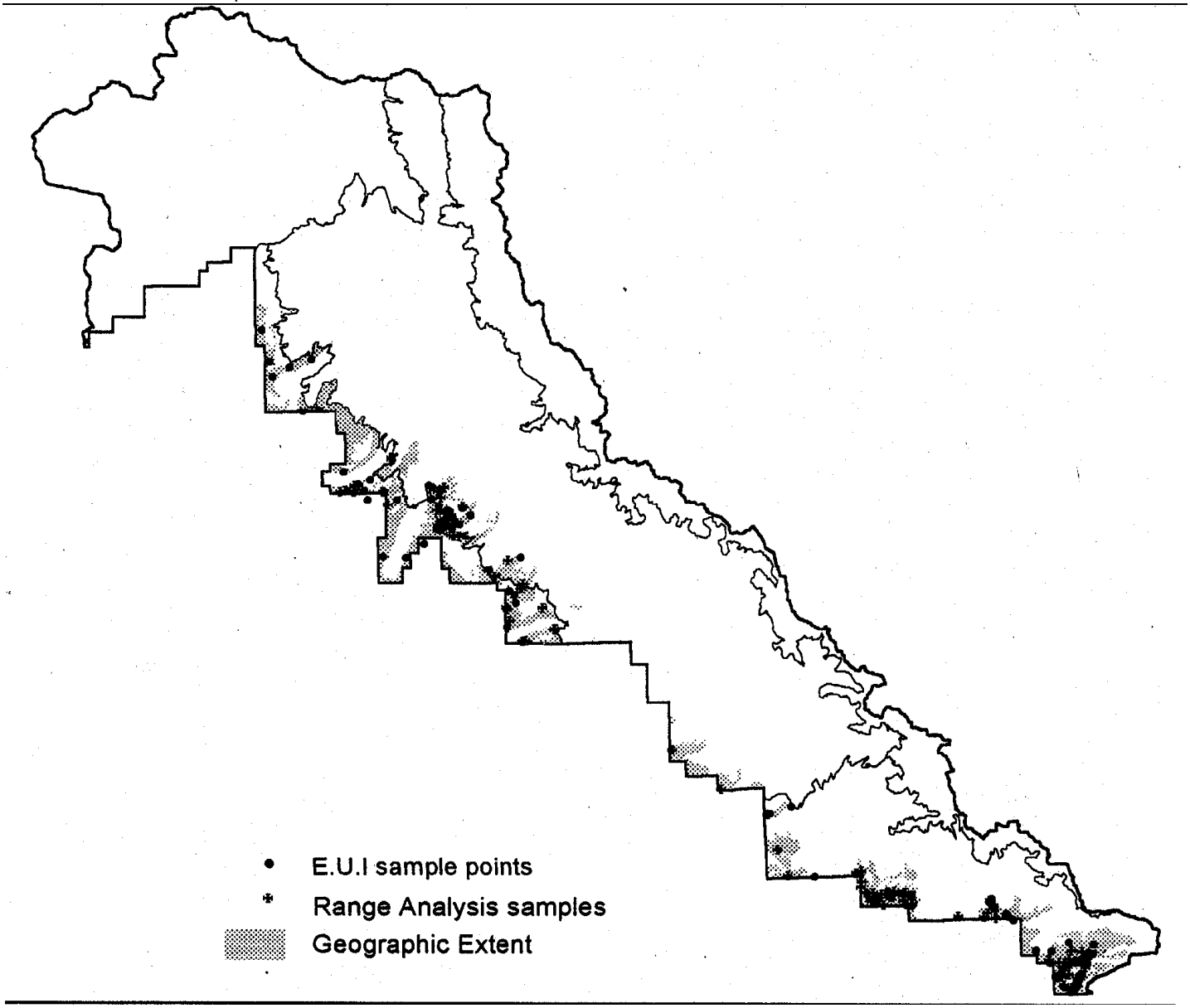
6321 Foothill Till Plains, Big Sagebrush Complex

6322 Foothill Moraines, Big Sagebrush Complex

6331 Foothil Moraines, Aspen - Big Sagebrush Complex

"**Wisdom** is the power to see, and the inclination to choose, the best and highest goal, together with the surest means of attaining it."
J.I. Packer

Mountain big sagebrush / **Idaho fescue - bluebunch wheatgrass** Plant Association
Artemisia tridentata var. ***pauciflora*** / ***Festuca idahoensis - Elymus spicatus*** p.a.
ARTRP4/FEID-ELSP3 p.a.



DISTRIBUTION AND EXTENT

The ARTRP4/FEID-ELSP3 p.a. occurs from McDowell Flat to the East Sweetwater River area at the south end of the Pinedale Ranger District. It is a major landscape component on approximately 50,300 acres and occupies about 19,900 acres within that area. The following table lists the geographic and areal extent of this plant association within each subsection.

Subsection	Geographic Extent	Areal Extent
Upper Green River Basin	22,600ac	9,000ac
Southeastern Wind River Mountains	18,300ac	7,600ac
Subsummit Uplands	9,400ac	3,300ac

ENVIRONMENT

Landforms: Sideslopes and summits of glacial moraines and till-mantled slopes, backslopes and shoulders of non-glaciated mountain slopes, and old alluvial terraces.

Parent materials: Glacial till, residuum, colluvium, or alluvium dominated by granitic materials.

n=189	Mean	Observed Range
Elevation (ft)	8301	7350 - 9250
Annual Precip. (in)	18	11 - 23
Slope (%)	13	0 – 70

Aspect: Predominantly south and west.

The environmental conditions in which this plant association occurs vary considerably between subsections. The following table lists the mean elevation, precipitation, and slope for each subsection.

Subsection:	Upper Green River Basin n = 56	Subsummit Uplands n = 34	Southeastern Mountains n=99
Elevation (ft)	7923	8504	8445
Annual Precip. (in)	14	17	20
Slope (%)	18	16	10

The most important difference between subsections is in mean annual precipitation. This difference corresponds to an opposite trend in soil depth and available water capacity across the subsections. (See SOILS.)

VEGETATION

Diagnostic Species: The ARTRP4/FEID-ELSP3 p.a. includes communities in which mountain big sagebrush cover is at least 5 percent and Idaho fescue cover is greater than 5 percent.

Shrubs: Mountain big sagebrush is dominant and forms a low to medium shrub layer 1 to 3 feet tall. Antelope bitterbrush cover is highly variable, but it is capable of growing throughout the range of this plant association. Green rabbitbrush and Utah mountain snowberry are often present in small amounts.

Herbs: Idaho fescue and bluebunch wheatgrass dominate the herb layer. Arrowleaf balsamroot, Indian paintbrush, and hawksbeard are often present.

Production: Total annual production (current year's growth of shrubs and herbs) averaged 700 lbs/acre on 86 range analysis transects, with a typical range of 350 to 1150 lbs/acre. This range reflects variation in environmental factors and annual climatic variation as well as the effects of disturbance. These transects were sampled between 1960 and 1983. They are on file at the Pinedale Ranger District.

Species Richness: The number of plant taxa per plot ($375m^2$) ranged from 12 to 35, with a mean of 23 across all seral stages. Late seral plots averaged 24 taxa present. This plant association ranked eighth out of ten in species richness.

SOILS

This plant association occurs mostly on soils with a sandy loam or gravelly sandy loam surface layer and a loamy-skeletal subsoil layer. In the Upper Green River Basin and Subsummit Uplands Subsections, the soils are deep and well drained. In the Southeastern Wind River Mountains, this plant association occurs almost exclusively on soils with a root and water restricting layer at a depth of less than 40 inches. This subsoil layer consists of either weathered granite or highly compacted soil. Above the restrictive layer, these soils are often coarser textured than those in the other subsections; they range from somewhat excessively drained to well drained.

The above soil differences between subsections result in considerable differences in properties related to plant growth. The mean values for these properties are listed for each subsection in the table below.

Subsection:	Upper Green River Basin n = 18	Subsummit Uplands n = 5	Southeastern Mountains n=28
Depth to Restrictive Layer (in)	53+	45+	33
Rooting Depth (in)	37	28	20
A.W.C. to 40 inches (in)	2.9	2.5	2.1
A.W.C. to rooting depth (in)	2.7	2.0	1.5

The trend in soil depth and available water capacity across the subsections is inverse to the trend in precipitation. These factors apparently compensate for one another, resulting in similar conditions for plant growth and the same potential natural vegetation.

The following table lists soil attributes and the percentage of this plant association's areal extent over which those attributes occur.

Attribute	Percent of Areal Extent
Depth to Restrictive Layer	
40 inches or more	59%
Less than 40 inches	41%
Particle Size Class of Subsoil	
Loamy-skeletal	84%
Fine-loamy	7%
Sandy-skeletal	6%
Coarse-loamy	3%
Drainage Class	
Well drained	76%
Somewhat excessively drained	24%
Clay Accumulation	
Argillic horizon present	35%
No argillic horizon	65%

This plant association most commonly occurs on the following soil families:

Loamy-skeletal, mixed Argic Pachic Cryoborolls
Loamy-skeletal, mixed Typic Cryoborolls
Loamy-skeletal, mixed Pachic Cryoborolls

ARTRP4/FEID-ELSP3 p.a. Plant Community Composition (n=97)

Common Name	Code	Late Seral[1] n = 21 Const	Late Seral[1] n = 21 Cover	Mid Seral n = 26 Const	Mid Seral n = 26 Cover	Early Seral n = 50 Const	Early Seral n = 50 Cover	Ecological Role
Shrubs:								
mountain big sagebrush	ARTRP4 **	100	21	100	21	100	20	Major climax increaser
green rabbitbrush	CHVI8	71	1	35	1	46	1	Minor climax increaser
Utah mountain snowberry	SYORU	71	1	23	1	6	1	Minor climax
antelope bitterbrush	PUTR2 *	67	10	58	3	34	3	Minor climax decreaser
creeping Oregon-grape	BERE	38	Tr	42	1	14	Tr	Minor climax, rocky sites
spiny phlox	LEPU	24	Tr	8	3	10	Tr	Minor climax increaser
Vasey big sagebrush	ARTRV2	-	-	12	3	4	3	Transition to moister p.a.
Perennial Grasses:								
bluebunch wheatgrass	ELSP3 **	100	20	73	10	50	3	Major climax decreaser
Idaho fescue	FEID **	100	15	92	19	100	14	Major climax decreaser
Columbia needlegrass	STNE3	67	2	46	2	32	3	Minor climax decreaser
needle-and-thread	STCO4	62	3	35	4	30	4	Minor climax increaser
Canby's bluegrass	POSEE	38	3	42	2	32	2	Minor climax decreaser
Sandberg bluegrass	POSES#	38	2	31	3	62	4	Minor climax increaser
mutton bluegrass	POFE	38	1	35	1	62	1	Minor climax decreaser
bottlebrush squirreltail	ELEL5	29	1	38	1	68	1	Minor climax increaser
prairie Junegrass	KOMA	29	1	12	1	16	1	Minor Climax Decreaser
Letterman's needlegrass	STLE4	14	Tr	27	3	74	3	Minor climax increaser
slender wheatgrass	ELTR7	5	Tr	12	1	6	Tr	On moist microsites
Sedges and Rushes:								
sedge	CAREX	48	1	46	2	46	2	Minor climax increaser
Ross' sedge	CARO5	24	1	42	1	40	1	Minor climax increaser
dryland sedge	CAXE	24	1	23	2	10	1	Minor climax increaser
Perennial Forbs:								
Indian paintbrush	CASTI2	90	1	62	1	66	1	Minor climax
arrowleaf balsamroot	BASA3 *	81	5	50	5	20	2	Minor climax decreaser
pussytoes	ANTEN	81	2	73	4	94	6	Increases on bared soil
pale bastard toadflax	COUMP2	76	1	50	1	22	1	Minor climax increaser
sulphur buckwheat	ERUM	71	2	73	3	78	2	Increases on bared soil
hawksbeard	CREPI	67	1	27	1	42	1	Minor climax decreaser
lupine	LUPIN	52	2	65	2	52	2	Minor climax increaser
rockcress	ARABI2	52	Tr	46	Tr	68	Tr	Minor climax
fleabane	ERIGE2	48	1	38	1	54	1	Minor climax increaser
groundsel	SENEC	38	1	35	1	48	1	Minor climax
Mariposa lily	CALOC	38	1	23	1	20	Tr	Minor climax decreaser
penstemon	PENST	38	1	23	Tr	6	1	Minor climax
oneflower helianthella	HEUN	33	3	8	3	4	1	Minor climax
longleaf phlox	PHLO2	33	1	15	1	6	1	Minor climax decreaser
skyrocket gilia	IPAG	29	1	31	1	30	Tr	Minor climax
stonecrop	SELA	29	Tr	23	Tr	42	Tr	Minor climax, rocky sites
ballhead sandwort	ARCO5	24	1	42	1	76	2	Increases on bared soil
oblongleaf bluebells	MEOB	19	1	19	Tr	36	1	Minor climax
pale agoseris	AGGL	19	Tr	31	1	40	2	Minor climax
broadfruit biscuitroot	LOTRP#	19	Tr	12	Tr	20	1	Minor climax
Oregon bitterroot	LERE7	19	Tr	4	Tr	32	Tr	Minor climax
biscuitroot	LOMAT	14	Tr	15	Tr	38	Tr	Minor climax
Hood's phlox	PHHO	5	1	38	2	66	1	Increases on bared soil
flowery phlox	PHMU3	5	1	38	2	74	2	Increases on bared soil
northwest cinquefoil	POGR9	5	Tr	4	Tr	26	Tr	Transition to moister p.a.
timber milkvetch	ASMI9	-	-	-	-	24	6	Minor climax increaser

** = Diagnostic species. * = Character species.

1. Seral stage is based on cover of understory decreasers and increasers; it is not directly related to sagebrush cover.

ASSOCIATED VEGETATION

On the Pinedale Ranger District, the ARTRP4/FEID-ELSP3 p.a. occurs most often in association with the ARTRP4-PUTR2/ELSP3 p.a. and forested communities dominated by quaking aspen or Douglas-fir. The table below lists the PNV types that occur as major landscape components within the geographic extent of the ARTRP4/FEID-ELSP3 p.a. and the area over which each PNV type is also a component.

Associated PNV	Acres in Association	Percent Co-occurrence
ARTRP4-PUTR2/ELSP3 p.a.	16,280	35%
POTR5/SYOR2/BRCA5 c.t.	13,430	29%
PSME/ARCO9 p.a.	10,120	21%
POTR5/BRCA5 c.t.	6,980	15%
POTR5/THFE c.t.	5,430	12%
PSME/SYOR2 p.a.	3,660	8%
POTR5/SYOR2/THFE c.t.	2,360	5%
PIFL2/FEID p.a.	2,350	5%
ABLA/ARCO9 p.a.	1,080	2%

SERAL STAGES

Seral stages are based on canopy cover of understory decreasers and increasers. Seral stage is not directly related to sagebrush cover. The following table compares the seral stages of this association in terms of canopy cover, ground cover, and environmental features. Environmental conditions are similar across seral stages with the exception of slope and precipitation. Late seral stands have the steepest slopes and early seral stands have the gentlest slopes. This relationship reflects livestock access. Precipitation is slightly higher on the early seral plots. This reflects the fact that this plant association has been subject to more disturbance in the Southeastern Wind River Mountains Subsection, which receives more precipitation.

	Late n=21	Mid n=26	Early n=50
Canopy Cover:			
Shrubs	28	23	21
Graminoids	41	33	14
Forbs	16	14	17
Cover Sum	89	73	67
Ground Cover:			
Basal Vegetation	8	6	6
Litter & Wood	69	57	47
Moss & Lichen	1	1	3
Rock	13	21	22
Bare Soil	8	16	22
Environment:			
Slope (%)	27	21	9
Precipitation (in)	15	17	19
Elevation (ft)	8090	8232	8355
Aspect	W,S,E	S,W,E	W,S,E,N

The table above indicates that the major effects of disturbance on this plant association include: a decrease in grass cover and total canopy cover, a decrease in litter, and an increase in the amount of bare soil. The higher rock cover in the mid and early seral stages is mostly gravel. This likely reflects the nature of the parent material in the Southeastern Wind River Mountains rather than a direct effect of disturbance.

MANAGEMENT IMPLICATIONS

Fire Response: Mountain big sagebrush plant associations have a natural fire frequency between 10 and 30 years (Winward 1991). Presettlement fires burned unevenly leaving islands and stringers of sagebrush unburned during any one fire. Fire intensity varied in the areas that did burn. The result of such fires was an ever changing mosaic of different densities and ages of sagebrush plants, ranging from recently burned, open grasslands to very dense sagebrush stands that had not burned in a long time (Winward 1991).

The seeds of mountain big sagebrush are stimulated to germinate by the heat of a fire (Champlin and Winward 1982; Hironaka *et al*. 1983; Crane and Fischer 1986). After a burn it can recover to 20 percent canopy cover in as little as 12 years (Winward 1991). In the absence of fire mountain big sagebrush continues to increase in density and cover, and may reach canopy cover values as high as 45 percent. If sagebrush canopy cover exceeds 20 percent for a long period of time, the density, cover, and biomass of herbaceous species will be reduced through shading and competition for moisture. Fire suppression over the last 80 years has allowed dense sagebrush canopies to develop over much the area occupied by this plant association. A 10 to 30 year cycle of sagebrush removal or thinning is needed to maintain natural amounts of grasses and forbs in this plant association (Hironaka *et al*. 1983).

Under the natural fire regime of this plant association, antelope bitterbrush was rejuvenated by fire through either resprouting following cool burns or by seed germination following hot fires (Driver 1983, 1990; Simon 1990). However, years of fire suppression have produced old, and often decadent, bitterbrush plants with little ability to resprout. Simon (1990) found that bitterbrush plants older that 50 years had very little resprouting ability.

Idaho fescue and bluebunch wheatgrass can both be severely damaged by hot summer fires. Bluebunch wheatgrass can also be damaged by a spring burn, between green up and flowering, when its root reserves are lowest. Both grasses can increase following the removal of sagebrush by a cool fire. For best results, a burned area should be rested from grazing for two growing seasons. Early seral stands may not improve even with rest because the depleted understory provides very little competition for new sagebrush seedlings. Under these conditions the understory cannot recover significantly by the time sagebrush canopy cover returns to preburn levels. In such cases shrub density may increase many-fold following a fire (Hironaka *et al*. 1983).

Big Game Habitat: This plant association provides important foraging areas for deer and elk. It is occasionally used by pronghorn antelope and moose. Where it occurs on south aspects in association with aspen and Douglas-fir it is an important component of elk winter range. Idaho fescue and bluebunch wheatgrass are highly preferred by elk and moderately preferred by deer. Antelope bitterbrush is highly preferred by both. Mountain big sagebrush is an important food source for deer and elk in fall and winter, but is rarely used in spring and summer. Any sagebrush removal or thinning should be done in a mosaic pattern to maintain winter browse while increasing herbaceous production.

Livestock Production: Idaho fescue and bluebunch wheatgrass are the principle forage species in this plant association. They are both highly preferred by cattle and moderately preferred by sheep. Antelope bitterbrush is highly preferred by both cattle and sheep. Livestock access is limited by steep slopes or lack of water in some areas.

Response to Grazing: Overgrazing will decrease the amounts of Idaho fescue, bluebunch wheatgrass, and bitterbrush. Other common decreasers include Columbia needlegrass, Canby's bluegrass, arrowleaf balsamroot, and hawksbeard. Species that increase with overgrazing include needle-and-thread, bottlebrush squirreltail, Letterman's needlegrass, pussytoes, sulphur buckwheat, ballhead sandwort, Hood's phlox, and flowery phlox.

Bluebunch wheatgrass is highly susceptible to damage from spring grazing, which depletes its root reserves and prevents it from producing seed. Repeated spring grazing can eliminate it from an area in a few years (USDA Forest Service 1937). To maintain bluebunch wheatgrass, grazing should be deferred until after seed set at least every third year. This may be difficult to do in areas that are used by wildlife in the spring.

Heavy grazing of understory species can enhance the natural tendency of mountain big sagebrush to increase in density and cover in two ways. First, by reducing competition from grasses and forbs. Second, by reducing fine fuels and thereby reducing the spread of wildfires. This increases the interval between fires and allows sagebrush cover to increase for a longer period of time.

Revegetation: The herbaceous layer of this plant association can be severely reduced by competition from overly dense sagebrush (see Fire Response) and/or improper grazing. Stands with moderately depleted understories may be capable of natural revegetation with appropriate management. However, recovery is likely to be slow on the drier sites occupied by this plant association. To promote natural revegetation, management must allow remnant desirable plants to increase in vigor and produce seed, and then allow seedlings to become established. This may require rest from grazing or deferment of grazing until after seed set.

If sagebrush cover is more than 20 percent, then some type of shrub removal will be needed to release the understory from competition (Winward 1991). Chemical or mechanical treatments will usually reduce sagebrush cover for a longer time period than prescribed burning because germination of mountain big sagebrush seeds is stimulated by the heat of a fire.

Watershed: In late seral stands of this plant association the canopy cover sum is typically between 73 and 103 percent, with a mean of 89 percent. Bare soil ranges from 0 to 15 percent. So in relatively undisturbed stands most, but not all, of the soil surface is protected from rain drop impact and surface runoff. In early seral stands the cover sum is typically between 50 and 86 percent, with a mean of 67 percent. Bare soil ranges from 3 to 55 percent, with a mean of 22 percent. Improper grazing and fire both reduce ground cover and expose more of the soil surface to rain drop impact and surface runoff. Stands with more than 20 percent bare soil are at risk of soil loss, which could lower site potential. This risk is greater on steeper slopes.

Much of the precipitation received by this plant association falls as snow and is subject to loss through sublimation and removal by wind. A sagebrush canopy helps minimize these losses. On the south and west-facing slopes typical of this plant association, sagebrush removal may increase snow loss and reduce the available moisture on the site. However, total water consumption is lower on sites where sagebrush is removed (Knight 1994). It is possible that dense sagebrush stands produced by fire suppression and overgrazing have reduced deep infiltration, ground water supplies, and stream flows from presettlement levels. The hydrologic effects of sagebrush are more pronounced on deeper soils (Knight 1994). In this plant association, sagebrush removal should affect water supplies more in the Upper Green River Basin and Subsummit Uplands subsections, which have deep soils, than in the Southeastern Wind River Mountains Subsection, where the soils usually have a restrictive layer at a depth of 15 to 40 inches.

COMPARISON TO OTHER STUDIES

Most classifications of sagebrush vegetation types have not taken big sagebrush taxonomy to the variety level, and big sagebrush taxonomy was refined after many of the classifications were done. These factors complicate the comparison of this plant association to other big sagebrush vegetation types.

This plant association is very similar to the "*Artemisia vaseyana* / *Festuca idahoensis*" habitat type (h.t.) described by Hironaka *et al*. (1983) in southern Idaho. That habitat type was named for *Artemisia tridentata* subspecies *vaseyana* but is dominated by variety *pauciflora*.

The ARTRP4/FEID-ELSP3 p.a. is probably similar to part of the very broad *Artemisia tridentata* / *Festuca idahoensis* h.t. described by Mueggler and Stewart (1980) in western Montana. That habitat type includes both subspecies *wyomingensis* and subspecies *vaseyana*. Based on the associated species described for that habitat type, the latter probably includes both variety *pauciflora* and variety *vaseyana.*

This plant association is also similar to the "xeric phase" of the *Purshia tridentata* / *Festuca idahoensis* h.t. described by Tweit and Houston (1980) on the Shoshone National Forest. That habitat type is described as being dominated by *Artemisia tridentata* subspecies *vaseyana* and *Purshia tridentata*.

E.U.I. CROSS REFERENCE

The following ecological types from the Bridger-East EUI are characterized by the ARTRP4/FEID-ELSP3 p.a.:

ARTRP4/FEID-ELSP3, Blanca Family ET
ARTRP4/FEID-ELSP3, Burgess Family ET
ARTRP4/FEID-ELSP3, Decram Family ET
ARTRP4/FEID-ELSP3, Forsey Family ET
ARTRP4/FEID-ELSP3, Keman Family ET
ARTRP4/FEID-ELSP3, Langer Family ET
ARTRP4/FEID-ELSP3, Lucky Family ET
ARTRP4/FEID-ELSP3, Tine Family ET

Ecological types characterized by the ARTRP4/FEID-ELSP3 p.a. occur as major components in the following map units from the Bridger-East EUI:

4343 Mountain Front Moraines, Subalpine fir - Aspen - Big Sagebrush Complex

4621 Mountain Front Sideslopes, Big Sagebrush - Douglas-fir Complex

4631 Mountain Front Sideslopes, Aspen - Big Sagebrush Complex

6321 Foothill Till Plains, Big Sagebrush Complex

6322 Foothill Moraines, Big Sagebrush Complex

6332 Foothill Moraines (Steep), Aspen - Big Sagebrush Complex

6333 Foothill Moraines, Aspen - Big Sagebrush - Douglas-fir Complex

6631 Foothill Sideslopes, Aspen - Big Sagebrush Complex

7221 Southeast Mountains Terraces, Big Sagebrush Complex

7222 Southeast Mountains Terraces, Big Sagebrush - Aspen Complex

7620 Southeast Mountains Sideslopes, Big Sagebrush - Limber Pine Complex

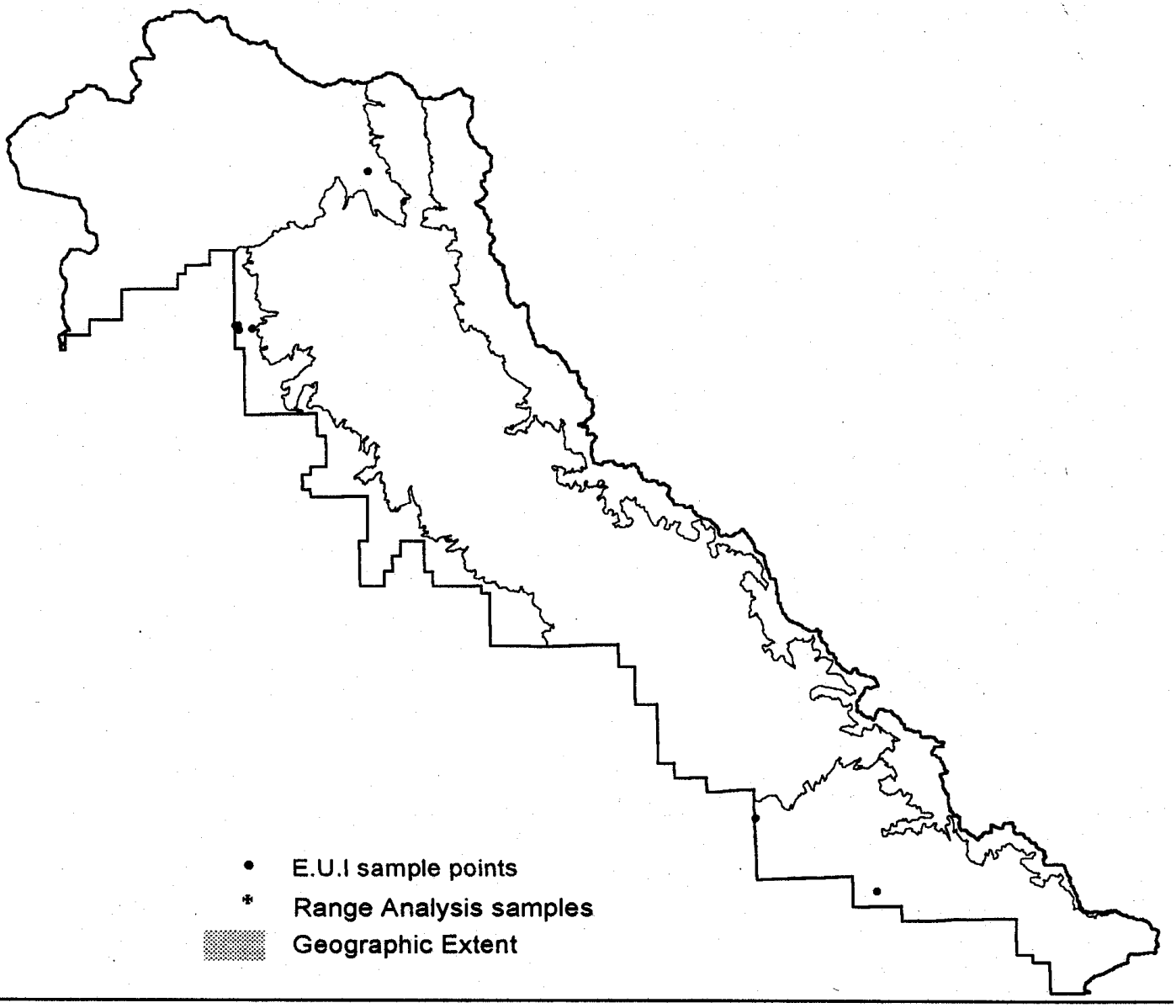
7621 Southeast Mountains Sideslopes, Big Sagebrush - Douglas-fir - Rock Outcrop Complex

7632 Southeast Mountains Sideslopes, Aspen - Big Sagebrush Complex

More detailed soil descriptions and more specific soil management interpretations are available in the ecological type and ecological map unit descriptions of the Bridger-East EUI.

"Against every great and noble idea there are a hundred mediocre minds."
Albert Einstein

Vasey big sagebrush - antelope bitterbrush Subseries
Artemisia tridentata var. ***vaseyana - Purshia tridentata*** Subseries
ARTRV2-PUTR2 Subseries



The ARTRV2-PUTR2 Subseries is a very minor PNV type on the Pinedale Ranger District, but may be more widespread elsewhere on the Bridger-Teton National Forest. It includes shrublands dominated by Vasey big sagebrush in which antelope bitterbrush is present to codominant. There is insufficient data available to subdivide this PNV type based on associated understory species, so it is referred to as a subseries rather than a plant association.

DISTRIBUTION AND EXTENT

The ARTRV2-PUTR2 Subseries has been observed most often between Boulder Creek and McDowell Flat in the Upper Green River Basin Subsection. It also occurs from Irish Canyon to Middle Squaw Creek in the Southeastern Wind River Mountains Subsection, and near Clear Creek in the Union Pass Uplands Subsection.

ENVIRONMENT

Landforms: Mostly sideslopes and crests of glacial moraines and till-mantled mountain slopes. Occasionally on old alluvial terraces or nonglaciated mountain slopes.

Parent materials: Mostly glacial till or colluvium derived from mixed sedimentary and granitic materials. Also alluvium or residuum derived from granitic materials.

n=7	Mean	Observed Range
Elevation (ft)	8343	8160 - 8780
Annual Precip. (in)	21	19 - 26
Slope (%)	23	3 - 57

Aspect: Predominantly south.

VEGETATION

Diagnostic Species: The ARTRV2-PUTR2 Subseries includes communities in which Vasey big sagebrush cover is at least 5 percent and antelope bitterbrush is present.

Shrubs: Vasey big sagebrush is dominant and forms a low to medium shrub layer 1 to 3 feet tall. Antelope bitterbrush is also present and sometimes codominates. Mountain big sagebrush is occasionally present and indicates transition toward the drier ARTRP4 Series.

Herbs: Idaho fescue and/or bluebunch wheatgrass dominate the herb layer in undisturbed stands. Other common herbs include Letterman's needlegrass, sulphur buckwheat, pussytoes, needle-and-thread, bottlebrush squirreltail, and flowery phlox.

Idaho fescue is absent and bluebunch wheatgrass is most abundant on steep, southerly slopes. This may be a basis for subdividing this subseries into plant associations. More data would be needed to verify and characterize such subdivisions.

Production: No range analysis transects have been identified as this subseries. Total annual production may be similar to the ARTRV2/FEID-ELSP3 p.a.

Species Richness: The number of plant taxa per plot ($375m^2$) ranged from 19 to 33, with a mean of 26 across all seral stages. Late seral plots averaged 29 taxa present. This subseries ranked sixth out of ten PNV types in species richness.

SOILS

In the Union Pass Uplands Subsection, the ARTRV2-PUTR2 Subseries has been observed on deep, well drained soils with a gravelly sandy loam or gravelly loam surface and a loamy-skeletal subsoil layer. There is sometimes a layer of clay accumulation in the subsoil. In the Southeastern Wind River Mountains Subsection, this subseries has been observed on soils that are less than 40 inches deep to bedrock and somewhat excessively drained. These soils have a gravelly sandy loam surface layer and a loamy-skeletal subsoil layer.

The following table lists mean values for soil properties closely related to plant growth.

n=3 Mean		Range
Depth to Restrictive Layer (in)	45+	26 - 60+
Rooting Depth (in)	30	19 - 46
A.W.C. to 40 inches (in)	2.5	1.5 - 3.3
A.W.C. to rooting depth (in)	2.2	1.5 - 3.7

This subseries has been observed on the following soil families:

Loamy-skeletal, mixed Typic Cryoborolls
Loamy-skeletal, mixed Argic Cryoborolls

ASSOCIATED VEGETATION

The ARTRV2-PUTR2 Subseries does not occur as a major landscape component within the Bridger-East EUI survey area. However, it has been observed adjacent to Douglas-fir forests and the ARTRV2/FEID-ELSP3 p.a.

SERAL STAGES

Seral stage is based on canopy cover of understory decreasers and increasers; it is not directly related to sagebrush cover. The following table compares the seral stages of this association in terms of canopy cover, ground cover, and environmental features.

	Late n=2	Mid n=2	Early n=3
Canopy Cover:			
Shrubs	38	35	17
Graminoids	45	35	20
Forbs	17	14	15
Cover Sum	110	97	53
Ground Cover:			
Basal Vegetation	9	7	5
Litter & Wood	75	61	29
Moss & Lichen	1	1	0
Rock	6	18	41
Bare Soil	9	14	25
Environment:			
Slope (%)	11	27	29
Precipitation (in)	20	21	23
Elevation (ft)	8290	8240	8450
Aspect	S	E,N	S

The table above indicates that environmental conditions are fairly uniform across seral stages except for aspect and the amount of rock on the soil surface. This limited data suggests that the major effects of disturbance on the ARTRV2-PUTR2 Subseries include decreases in grass cover total canopy cover, and litter; and an increase in the amount of bare soil.

MANAGEMENT IMPLICATIONS

Fire Response: Vasey big sagebrush communities have a natural fire frequency between 20 and 40 years (Winward 1991). Presettlement fires burned unevenly leaving islands and stringers of sagebrush unburned during any one fire. Fire intensity varied in the areas that did burn. The result of such fires was an ever changing mosaic of different densities and ages of sagebrush plants, ranging from recently burned, open grasslands to very dense sagebrush stands that had not burned in a long time (Winward 1991).

The seeds of Vasey big sagebrush are stimulated to germinate by the heat of a fire (Champlin and Winward 1982; Hironaka *et al*. 1983; Crane and Fischer 1986). After a burn it can recover to 20 percent canopy cover in as little as 12 years (Winward 1991). In the absence of

ARTRV2-PUTR2 Subseries Plant Community Composition (n=7)

Common Name	Code	Late Seral[1] n = 2 Const	Late Seral[1] n = 2 Cover	Mid Seral n = 2 Const	Mid Seral n = 2 Cover	Early Seral n = 3 Const	Early Seral n = 3 Cover	Ecological Role
Shrubs:								
Vasey big sagebrush	ARTRV2 **	100	25	100	31	67	18	Major climax increaser
antelope bitterbrush	PUTR2 **	100	13	100	4	100	4	Major climax decreaser
mountain big sagebrush	ARTRP4	50	5	-	-	33	4	Transition to drier p.a.
creeping Oregon-grape	BERE	-	-	50	1	33	1	Minor climax, rocky sites
Utah mountain snowberry	SYORU	-	-	50	Tr	33	Tr	Minor climax
Perennial Grasses:								
Idaho fescue	FEID *	100	23	50	25	67	8	Major climax decreaser
Letterman's needlegrass	STLE4	100	7	50	5	-	-	Minor climax increaser
needle-and-thread	STCO4	100	3	-	-	33	Tr	Minor climax increaser
bottlebrush squirreltail	ELEL5	100	2	50	1	67	1	Minor climax increaser
bluebunch wheatgrass	ELSP3 *	50	4	100	14	100	8	Major climax decreaser
big bluegrass	POJUA	50	4	-	-	-	-	Minor climax decreaser
Kentucky bluegrass	POPR	50	4	-	-	-	-	Transition to moister site
Sandberg bluegrass	POSES#	50	4	-	-	-	-	Minor climax increaser
mutton bluegrass	POFE	50	2	50	3	33	Tr	Minor climax decreaser
Columbia needlegrass	STNE3	50	2	50	2	33	1	Minor climax decreaser
prairie Junegrass	KOMA	50	Tr	100	1	-	-	Minor climax decreaser
King's spikefescue	HEKI	50	Tr	50	Tr	33	2	Minor climax decreaser
nodding brome	BRAN	50	Tr	50	Tr	33	Tr	Minor climax decreaser
Cusick's bluegrass	POCU3	-	-	-	-	33	1	Minor climax decreaser
Canby's bluegrass	POSEE	-	-	-	-	33	1	Minor climax decreaser
Sedges and Rushes:								
obtuse sedge	CAOB4	50	4	100	5	33	5	Minor climax increaser
sedge	CAREX	50	8	50	Tr	67	1	Minor climax
Perennial Forbs:								
sulphur buckwheat	ERUM	100	6	100	7	100	2	Increases on bared soil
pussytoes	ANTEN	100	5	100	9	100	7	Increases on bared soil
flowery phlox	PHMU3	100	2	50	Tr	33	Tr	Increases on bared soil
rockcress	ARABI2	100	Tr	100	Tr	100	Tr	Minor climax
cushion buckwheat	EROV	50	3	-	-	-	-	Minor climax
Hood's phlox	PHHO	50	2	-	-	67	2	Increases on bared soil
ballhead sandwort	ARCO5	50	1	50	Tr	33	2	Increases on bared soil
prairiesmoke	GETR	50	1	-	-	-	-	On moist microsites
skyrocket gilia	IPAG	50	Tr	100	Tr	67	1	Minor climax
aster	ASTER	50	Tr	50	Tr	67	2	Minor climax increaser
Indian paintbrush	CASTI2	50	Tr	50	Tr	67	Tr	Minor climax
common dandelion	TAOF	50	Tr	50	Tr	67	Tr	Alien increaser
biscuitroot	LOMAT	50	Tr	-	-	33	Tr	Minor climax
groundsel	SENEC	50	Tr	-	-	33	Tr	Minor climax
arrowleaf balsamroot	BASA3	-	-	50	5	33	Tr	Minor climax decreaser
oneflower helianthella	HEUN	-	-	50	2	-	-	Minor climax
Jessica stickseed	HAMI	-	-	50	1	-	-	Minor climax increaser
hawksbeard	CREPI	-	-	50	Tr	67	1	Minor climax decreaser
western yarrow	ACMIL3	-	-	50	Tr	33	2	Minor climax increaser
Mariposa lily	CALOC	-	-	50	Tr	33	Tr	Minor climax decreaser
pale bastard toadflax	COUMP2	-	-	50	Tr	33	Tr	Minor climax increaser
northwest cinquefoil	POGR9	-	-	50	Tr	33	Tr	Transition to moister p.a.
stonecrop	SEDUM	-	-	50	Tr	33	Tr	Minor climax, rocky sites
Annual Forbs:	AAFF	100	1	50	1	67	1	Minor climax or seral

** = Diagnostic species. * = Character species.

1. Seral stage is based on cover of understory decreasers and increasers; it is not directly related to sagebrush cover.

fire Vasey big sagebrush continues to increase in density and cover, and may reach canopy cover values as high as 45 percent. If sagebrush canopy cover exceeds 20 percent for a long period of time, the density, cover, and biomass of herbaceous species will be reduced through shading and competition for moisture. A 20 to 40 year cycle of sagebrush removal or thinning may be needed to maintain natural amounts of grasses and forbs in this subseries (Hironaka *et al*. 1983).

Under the natural fire regime of this subseries, antelope bitterbrush was rejuvenated by fire through either resprouting following cool burns or by seed germination following hot fires (Driver 1983, 1990; Simon 1990). However, years of fire suppression have produced old, and often decadent, bitterbrush plants with little ability to resprout. Simon (1990) found that bitterbrush plants older that 50 years had very little resprouting ability.

Idaho fescue and bluebunch wheatgrass can both be severely damaged by hot summer fires. Bluebunch wheatgrass can also be damaged by a spring burn, between green up and flowering, when its root reserves are lowest. Both grasses can increase following the removal of sagebrush by a cool fire. For best results, a burned area should be rested from grazing for two growing seasons. Severely depleted stands may not improve even with rest because the sparse understory provides very little competition for new sagebrush seedlings. Under these conditions the understory cannot recover significantly by the time sagebrush canopy cover returns to preburn levels. In such cases shrub density may increase many-fold following a fire (Hironaka *et al*. 1983).

Big Game Habitat: This subseries provides important foraging areas for elk and is occasionally used by deer. It is a minor component of elk winter range on the Pinedale Ranger District. Idaho fescue and bluebunch wheatgrass are highly preferred by elk and moderately preferred by deer. Bitterbrush is highly preferred by both. Vasey big sagebrush is an important food source for deer and elk in fall and winter, but is rarely used in spring and summer. Any shrub removal or thinning should be done in a mosaic pattern to maintain winter browse while increasing herbaceous production.

Livestock Production: Idaho fescue and bluebunch wheatgrass are the principle forage species in this subseries. They are both highly preferred by cattle and moderately preferred by sheep. Antelope bitterbrush is highly preferred by both cattle and sheep. This subseries often occurs on steep slopes which restrict livestock access.

Response to Grazing: Heavy grazing will decrease the amounts of Idaho fescue, bluebunch wheatgrass, antelope bitterbrush, and Columbia needlegrass. Species that increase with overgrazing include bottlebrush squirreltail, Letterman's needlegrass, pussytoes, sulphur buckwheat, flowery phlox, and dryland sedges.

Bluebunch wheatgrass is highly susceptible to damage from spring grazing, which depletes its root reserves and prevents it from producing seed. Repeated spring grazing can eliminate it from an area in a few years (USDA Forest Service 1937). To maintain bluebunch wheatgrass, grazing should be deferred until after seed set at least every third year. This may be difficult to achieve in areas that are used by wildlife in the spring.

Heavy grazing of the understory species can enhance the natural tendency of mountain big sagebrush to increase in density and cover in two ways. First, by reducing competition from grasses and forbs. Second, by reducing fine fuels and thereby reducing the spread of wildfires. This increases the interval between fires and allows sagebrush cover to increase for a longer period of time.

Revegetation: The herbaceous layer of this subseries can be severely reduced by competition from an overly dense sagebrush canopy (see Fire Response) and/or improper grazing. Stands with moderately depleted understories may be capable of natural revegetation with appropriate management. Such management must allow desirable plants to increase in vigor and produce seed, and then allow seedlings to become established. This may require rest from grazing or deferment of grazing until after seed set. If sagebrush cover is more than 20 percent, then some type of shrub removal will be needed to release the understory from competition (Winward 1991). Chemical or mechanical treatments will usually reduce sagebrush cover for a longer time period than prescribed burning because germination of Vasey big sagebrush seeds is stimulated by the heat of a fire.

Damage from rodent burrowing can also hamper natural revegetation. However, little rodent activity has been observed in this subseries.

Watershed: In late seral stands of this subseries the canopy cover sum averages 110 percent. Bare soil averages 9 precent. So in relatively undisturbed stands most, but not all, of the soil surface is protected from rain drop impact and surface runoff. In early seral stands the cover sum is typically between 48 and 62 percent, with a mean of 53 percent. Bare soil ranges from 20 to 30 percent. Improper grazing, fire, and rodent activity reduce ground cover and expose more of the soil surface to rain drop impact and surface runoff. Stands with more than 20 percent bare soil are at risk of soil loss, which could lower site potential. This risk is greater on steeper slopes.

Much of the precipitation received by this subseries falls as snow and is subject to loss through sublimation and removal by wind. A shrub canopy helps minimize these losses. On the south-facing slopes typical of this subseries, sagebrush removal may increase snow loss and reduce the available moisture on the site. However, total water consumption is lower on sites where sagebrush is removed (Knight 1994). It is possible that dense sagebrush stands produced by fire suppression and overgrazing have reduced deep infiltration, ground water supplies, and stream flows from presettlement levels. The hydrologic effects of sagebrush are more pronounced on deeper soils (Knight 1994).

COMPARISON TO OTHER STUDIES

Most classifications of sagebrush vegetation types have not taken big sagebrush taxonomy to the variety level, and big sagebrush taxonomy was refined after many of the classifications were done. These factors complicate the comparison of this plant association to other big sagebrush vegetation types.

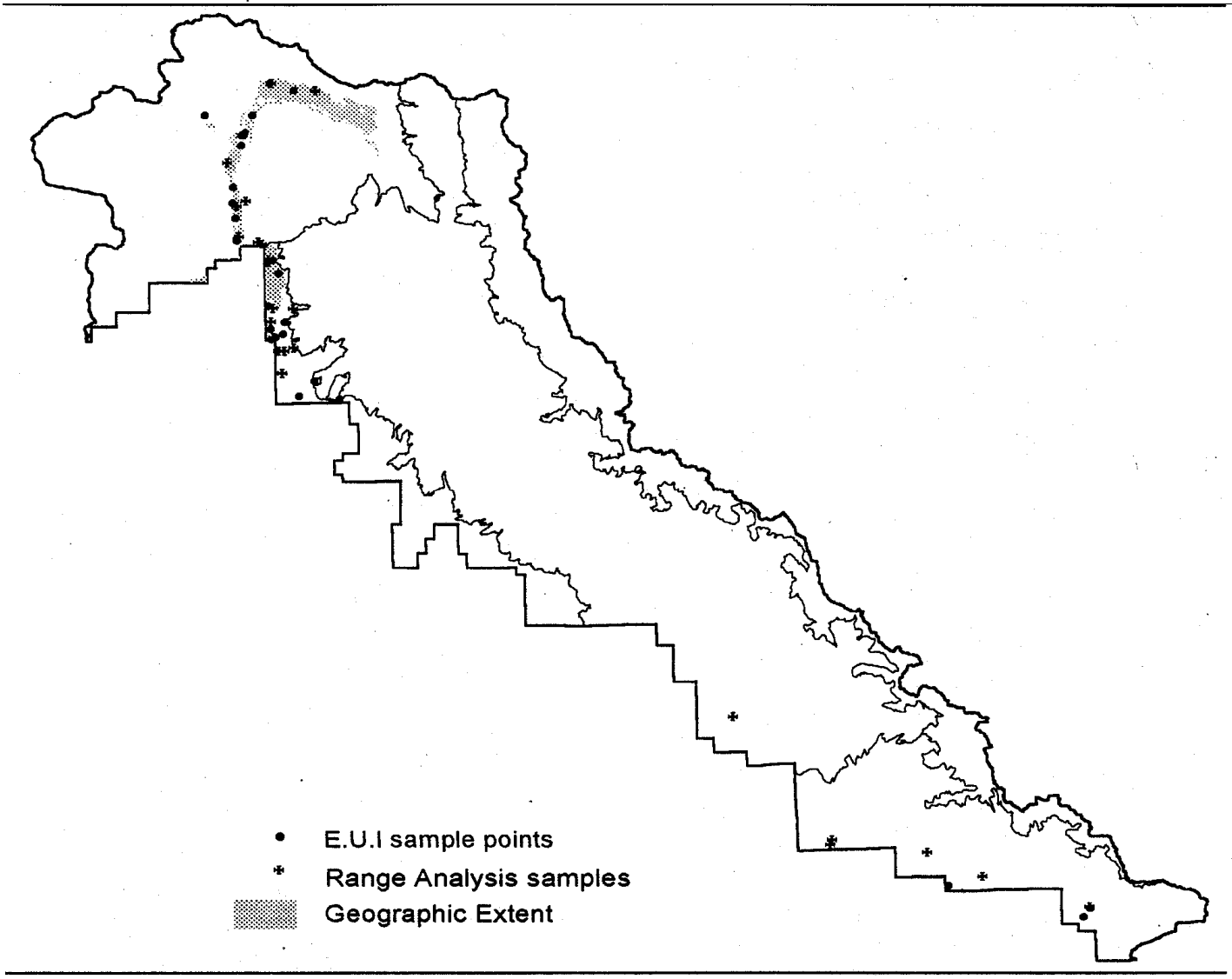
This plant association may correspond to part of the *Purshia tridentata* / *Festuca idahoensis* h.t. described by Tweit and Houston (1980) on the Shoshone National Forest. That habitat type occurs on south and west aspects on sedimentary parent materials.

E.U.I. CROSS REFERENCE

This subseries is not used to characterize any ecological types in the Bridger East EUI and is not a major component of any map units.

"The trouble with trying to make yourself stupider than you really are is that you very often succeed."
C.S. Lewis

Vasey big sagebrush / **Idaho fescue - bluebunch wheatgrass** Plant Association
Artemisia tridentata var. ***vaseyana*** / ***Festuca idahoensis - Elymus spicatus*** p.a.
ARTRV2/FEID-ELSP3 p.a.



DISTRIBUTION AND EXTENT

The ARTRV2/FEID-ELSP3 p.a. occurs along the Green River from Green River Lakes to Kendall Guard Station in the Union Pass Uplands Subsection, and from Gypsum Creek to Boulder Creek in the Upper Green River Basin Subsection. It is a major landscape component on approximately 12,700 acres and occupies about 4,500 acres within that area. The following table lists the geographic and areal extents of this plant association within each subsection.

Subsection	Geographic Extent	Areal Extent
Union Pass Uplands	10,300ac	3,600ac
Upper Green River Basin	2,400ac	900ac

It also occurs in minor amounts in the Subsummit Uplands and Southeastern Wind River Mountains Subsections.

ENVIRONMENT

Landforms: Mostly glaciofluvial and alluvial terraces; also backslopes, benches, and summits of glacial moraines and till-mantled mountain slopes.

Parent materials: Glacial till, alluvium, or glaciofluvial deposits derived from mixed sedimentary and granitic materials.

n=56	Mean	Observed Range
Elevation (ft)	8181	7620 - 9320
Annual Precip. (in)	21	14 - 27
Slope (%)	12	0 - 50

Aspect: Predominantly south and west.

The environmental conditions in which this plant association occurs vary considerably between subsections. The following table lists the mean elevation, mean precipitation, and median slope for each subsection.

Subsection:	Upper Green River Basin n = 22	Union Pass Uplands n = 23	Southeastern Mountains n = 8
Elevation (ft)	8045	7953	9013
Annual Precip. (in)	18	24	24
Slope (%)	9	3	7

The most important difference between the Union Pass Uplands and Upper Green River Basin Subsections is in mean annual precipitation. This difference corresponds to an inverse trend in available water capacity across the subsections. (See SOILS.)

VEGETATION

Diagnostic Species: The ARTRV2/FEID-ELSP3 p.a. includes communities in which Vasey big sagebrush cover is at least 5 percent and the understory is characterized by Idaho fescue and bluebunch wheatgrass. More mesic species, such as slender wheatgrass and northwest cinquefoil are absent or restricted to moist microsites.

Shrubs: Vasey big sagebrush is dominant and forms a medium shrub layer 2 to 3 feet tall. Green rabbitbrush and Utah mountain snowberry are often present in small amounts. Mountain big sagebrush is occasionally present and indicates transition toward the drier ARTRP4/FEID-ELSP3 p.a.

Herbs: Idaho fescue and bluebunch wheatgrass dominate the herb layer. Sulphur buckwheat, pussytoes, prairie junegrass, ballhead sandwort, and Indian paintbrush are often present.

Production: Total annual production (current year's growth of shrubs and herbs) averaged 780 lbs/acre on 23 range analysis transects, with a typical range of 350 to 1400 lbs/acre. This range reflects variation in environmental factors and annual climatic variation as well as the effects of disturbance. These transects were sampled between 1961 and 1983. They are on file at the Pinedale Ranger District.

Species Richness: The number of plant taxa per plot ($375m^2$) ranged from 11 to 39, with a mean of 27 across all seral stages. Late seral plots averaged 29 taxa present. This plant association ranked fifth out of ten in species richness.

SOILS

This plant association predominantly occurs on deep soils that are well drained to somewhat excessively drained. In the Union Pass Uplands Subsection, it occurs mostly on soils with a sandy loam or fine sandy loam surface and a loamy-skeletal or sandy subsoil layer. In the Upper Green River Basin Subsection, the soils typically have a loamy surface layer and a fine-loamy subsoil. In the Southeastern Wind River Mountains, this plant association has been observed on soils with a root and water restricting layer at a depth of less than 40 inches. This layer consists of either weathered granite or highly compacted soil.

The above soil differences between subsections result in considerable differences in properties related to plant growth. The mean values for these properties are listed for each subsection in the table below.

Subsection:	Upper Green River Basin n = 8	Union Pass Uplands n = 11	Southeastern Mountains n=2
Depth to Restrictive Layer (in)	59+	53+	21
Rooting Depth (in)	39	24	16
A.W.C. to 40 inches (in)	4.6	2.8	1.3
A.W.C. to rooting depth (in)	4.0	2.1	1.1

The trend in rooting depth and available water capacity across the subsections is inverse to the trend in precipitation. These factors apparently compensate for one another, resulting in similar conditions for plant growth and the same potential natural vegetation.

The following table lists soil attributes and the percentage of this plant association's areal extent over which those attributes occur.

Attribute	Percent of Areal Extent
Depth to Restrictive Layer	
40 inches or more	100%
Particle Size Class of Subsoil	
Loamy-skeletal	58%
Sandy-skeletal	23%
Fine-loamy	19%
Drainage Class	
Well drained	77%
Somewhat excessively drained	23%
Clay Accumulation	
Argillic horizon present	19%
No argillic horizon	81%

This plant association most commonly occurs on the following soil families:

Loamy-skeletal, mixed Typic Cryoborolls
Sandy, mixed Typic Cryoborolls
Fine-loamy, mixed Argic Pachic Cryoborolls

ARTRV2/FEID-ELSP3 p.a. Plant Community Composition (n=33)

Common Name	Code	Late Seral[1] n = 6 Const	Late Seral[1] n = 6 Cover	Mid Seral n = 11 Const	Mid Seral n = 11 Cover	Early Seral n = 16 Const	Early Seral n = 16 Cover	Ecological Role
Shrubs:								
Vasey big sagebrush	ARTRV2 **	100	28	100	24	94	23	Major climax increaser
mountain big sagebrush	ARTRP4	33	3	9	22	25	11	Transition to drier p.a.
green rabbitbrush	CHVI8	17	Tr	36	1	38	1	Minor climax increaser
Utah mountain snowberry	SYORU	17	Tr	36	1	38	Tr	Transition to moister p.a.
Perennial Grasses:								
Idaho fescue	FEID *	100	33	100	25	88	9	Major climax decreaser
bluebunch wheatgrass	ELSP3 **	83	13	91	6	56	4	Major climax decreaser
prairie Junegrass	KOMA	83	2	73	2	52	2	Minor climax decreaser
Columbia needlegrass	STNE3	50	2	82	4	31	4	Minor climax decreaser
needle-and-thread	STCO4	50	1	55	4	50	4	Minor climax increaser
mutton bluegrass	POFE	50	1	18	3	44	4	Minor climax decreaser
Letterman's needlegrass	STLE4	33	4	18	8	63	7	Minor climax increaser
alkali bluegrass	POJU	33	2	9	1	13	Tr	Minor climax decreaser
Sandberg bluegrass	POSES#	33	2	36	4	50	5	Minor climax increaser
bottlebrush squirreltail	ELEL5	33	1	55	1	63	1	Minor climax increaser
Sedges and Rushes:								
obtuse sedge	CAOB4	67	2	64	4	38	1	Minor climax increaser
dryland sedge	CAXE	33	1	18	1	13	1	Minor climax increaser
threadleaf sedge	CAFI	17	10	9	7	25	Tr	Minor climax increaser
sedge	CAREX	17	Tr	67	1	81	3	Minor climax increaser
Perennial Forbs:								
sulphur buckwheat	ERUM	100	5	100	6	75	3	Increases on bared soil
pussytoes	ANTEN	100	2	100	4	100	7	Increases on bared soil
rockcress	ARABI2	100	Tr	73	Tr	75	Tr	Minor climax
groundsel	SENEC	100	Tr	36	Tr	44	Tr	Minor climax
ballhead sandwort	ARCO5	83	1	45	2	63	1	Increases on bared soil
Indian paintbrush	CASTI2	83	1	64	1	75	1	Minor climax
western yarrow	ACMIL3	67	1	73	1	25	Tr	Minor climax increaser
prairiesmoke	GETR	67	Tr	45	Tr	56	1	Minor climax increaser
longleaf phlox	PHLO2	67	Tr	27	1	25	Tr	Minor climax decreaser
lupine	LUPIN	50	2	91	5	63	2	Minor climax increaser
oneflower helianthella	HEUN	50	2	55	4	13	1	Minor climax
common dandelion	TAOF	50	Tr	55	Tr	31	Tr	Alien increaser
northwest cinquefoil	POGR9	50	Tr	45	Tr	25	Tr	Transition to moister p.a.
nodding microseris	MINU	50	Tr	9	Tr	6	1	Minor climax decreaser
hawksbeard	CREPI	33	2	27	1	25	1	Minor climax decreaser
flowery phlox	PHMU3	33	2	9	Tr	31	3	Increases on bared soil
green gentian	SWRA	33	1	45	1	13	2	Minor climax
sticky geranium	GEVI2	33	1	45	Tr	19	1	Transition to moister p.a.
stonecrop	SEDUM	33	1	27	1	25	Tr	Minor climax, rocky sites
fleabane	ERIGE2	33	1	18	1	19	1	Minor climax increaser
manyglands cinquefoil	POGLP2	33	Tr	55	1	13	1	Minor climax increaser
western gromwell	LIRU4	33	Tr	18	2	6	1	Minor climax increaser
Hood's phlox	PHHO	17	2	9	Tr	69	1	Increases on bared soil
pale bastard toadflax	COUMP2	17	1	27	1	6	2	Minor climax increaser
arrowleaf balsamroot	BASA3	-	-	36	3	6	3	Minor climax decreaser
Annual Forbs:								
yellow owlclover	ORLU2	50	Tr	36	Tr	25	Tr	Minor climax increaser
whitlowgrass	DRABA	50	Tr	-	-	13	Tr	Minor climax increaser
Douglas' knotweed	PODO4	33	Tr	36	1	19	Tr	Increases on bared soil
pygmyflower rockjasmine	ANSES	33	Tr	36	Tr	56	Tr	Minor climax increaser

** = Diagnostic species. * = Character species.

1. Seral stage is based on cover of understory decreasers and increasers; it is not directly related to sagebrush cover.

ASSOCIATED VEGETATION

On the Pinedale Ranger District, the ARTRV2/FEID-ELSP3 p.a. occurs most often in association with shrubby cinquefoil communities. In the Union Pass Uplands, it is always associated with the POFR4/FEID c.t. In the Upper Green River Basin Subsection, it is associated with the POFR4/DECE c.t. The table below lists the PNV types that occur as major landscape components within the geographic extent of the ARTRV2/FEID-ELSP3 p.a. and the area over which each PNV type is also a component.

Associated PNV	Acres in Association	Percent Co-occurrence
POFR4/FEID c.t.	10,300	81%
ARTRV2/STRI2 p.a.	5,960	47%
ARCAV2/FEID c.t.	2,740	21%
POFR4/DECE c.t.	2,390	19%
POTR5/THFE c.t.	2,390	19%

SERAL STAGES

Seral stage is based on canopy cover of understory decreasers and increasers; it is not directly related to sagebrush cover. The following table compares the seral stages of this association in terms of canopy cover, ground cover, and environmental features. Environmental conditions are similar across seral stages.

	Late n=6	Mid n=10	Early n=13
Canopy Cover:			
Shrubs	29	30	26
Graminoids	53	44	25
Forbs	16	25	18
Cover Sum	103	103	73
Ground Cover:			
Basal Vegetation	10	8	6
Litter & Wood	77	75	56
Moss & Lichen	1	2	2
Rock	5	8	14
Bare Soil	7	7	21
Environment:			
Slope (%)	11	10	8
Precipitation (in)	22	20	22
Elevation (ft)	8073	7912	8188
Aspect	E,W,S,N	W,E,S,N	S,W,E,N

The table above indicates that the major effects of disturbance on this plant association include: a decrease in grass cover and total canopy cover, a decrease in litter, and an increase in the amount of bare soil.

MANAGEMENT IMPLICATIONS

Fire Response: Vasey big sagebrush plant associations have a natural fire frequency between 20 and 40 years (Winward 1991). Presettlement fires burned unevenly leaving islands and stringers of sagebrush unburned during any one fire. Fire intensity varied in the areas that did burn. The result of such fires was an ever changing mosaic of different densities and ages of sagebrush plants, ranging from recently burned, open grasslands to very dense sagebrush stands that had not burned in a long time (Winward 1991).

The seeds of Vasey big sagebrush are stimulated to germinate by the heat of a fire (Champlin and Winward 1982; Hironaka *et al*. 1983; Crane and Fischer 1986). After a burn it can recover to 20 percent canopy cover in as little as 12 years (Winward 1991). In the absence of fire Vasey big sagebrush continues to increase in density and cover, and may reach canopy cover values as high as 45 percent. If sagebrush canopy cover exceeds 20 percent for a long period of time, the density, cover, and biomass of herbaceous species will be reduced through shading and competition for moisture. Fire suppression over the last 80 years has allowed dense sagebrush canopies to develop over much of the area occupied by this plant association. A 20 to 40 year cycle of sagebrush removal or thinning is needed to maintain natural amounts of grasses and forbs in this plant association (Hironaka *et al*. 1983).

Idaho fescue and bluebunch wheatgrass can both be severely damaged by hot summer fires. Bluebunch wheatgrass can also be damaged by a spring burn, between green up and flowering, when its root reserves are lowest. Both grasses can increase following the removal of sagebrush by a cool fire. For best results, a burned area should be rested from grazing for two growing seasons. Severely depleted stands may not improve even with rest because the sparse understory provides very little competition for new sagebrush seedlings. Under these conditions the understory cannot recover significantly by the time sagebrush canopy cover returns to preburn levels. In such cases shrub density may increase many-fold following a fire (Hironaka *et al*. 1983).

Big Game Habitat: This plant association provides important foraging areas for deer and elk. It is occasionally used by pronghorn antelope and moose. Where it occurs in association with aspen it is an important component of elk winter range. Idaho fescue and bluebunch wheatgrass are highly preferred by elk and moderately preferred by deer. Vasey big sagebrush is an important food source for deer and elk in fall and winter, but is rarely used in spring and summer. Any sagebrush removal or thinning should be done in a mosaic pattern to maintain winter browse while increasing herbaceous production.

Livestock Production: Idaho fescue and bluebunch wheatgrass are the principle forage species in this plant association. They are both highly preferred by cattle and moderately preferred by sheep. This plant association occurs mostly on gentle slopes which do not restrict livestock access.

Response to Grazing: Overgrazing will decrease the amounts of Idaho fescue, bluebunch wheatgrass, prairie junegrass, and Columbia needlegrass. Species that increase with overgrazing include needle-and-thread, bottlebrush squirreltail, Letterman's needlegrass, pussytoes,

sulphur buckwheat, Hood's phlox, and dryland sedges.

Bluebunch wheatgrass is highly susceptible to damage from spring grazing, which depletes its root reserves and prevents it from producing seed. Repeated spring grazing can eliminate it from an area in a few years (USDA Forest Service 1937). To maintain bluebunch wheatgrass, grazing should be deferred until after seed set at least every third year. This may be difficult to achieve in areas that are used by wildlife in the spring.

Heavy grazing of understory species can enhance the natural tendency of Vasey big sagebrush to increase in density and cover in two ways. First, by reducing competation from grasses and forbs. Second, by reducing fine fuels and thereby reducing the spread of wildfires. This increases the interval between fires and allows sagebrush cover to increase for a longer period of time.

Revegetation: The herbaceous layer of this plant association can be severely reduced by competition from an overly dense sagebrush canopy (see Fire Response) and/or improper grazing. Stands with moderately depleted understories are often capable of natural revegetation with appropriate management. Such management must allow desirable plants to increase in vigor and produce seed, and then allow seedlings to become established. This may require rest from grazing or deferment of grazing until after seed set.

When sagebrush cover is more than 20 percent, some type of shrub removal will be needed to release the understory from competition (Winward 1991). Chemical or mechanical treatments will usually reduce sagebrush cover for a longer time period than prescribed burning because germination of Vasey big sagebrush seeds is stimulated by the heat of a fire.

Damage from rodent burrowing can also hamper natural revegetation. However, little rodent activity has been observed this plant association and none has been observed in early seral stands.

Watershed: In late seral stands of this plant association the canopy cover sum is between 88 and 112 percent, with a mean of 103 percent. Bare soil ranges from 1 to 15 percent, with a mean of 7 precent. So in relatively undisturbed stands most, but not all, of the soil surface is protected from rain drop impact and surface runoff. In early seral stands the cover sum is typically between 50 and 86 percent, with a mean of 67 percent. Bare soil ranges from 5 to 50 percent, with a mean of 21 percent. Improper grazing, fire, and rodent activity reduce ground cover and expose more of the soil surface to rain drop impact and surface runoff. Stands with more than 20 percent bare soil are at risk of soil loss, which could lower site potential.

Much of the precipitation received by this plant association falls as snow and is subject to loss through sublimation and removal by wind. A sagebrush canopy helps minimize these losses. On the south and west-facing slopes typical of this plant association, sagebrush removal may increase snow loss and reduce the available moisture on the site. However, total water consumption is lower on sites where sagebrush is removed (Knight 1994). It is possible that dense sagebrush stands produced by fire suppression and overgrazing have reduced deep infiltration, ground water supplies, and stream flows from presettlement levels. The hydrologic effects of sagebrush are more pronounced on deeper soils (Knight 1994).

COMPARISON TO OTHER STUDIES

Most classifications of sagebrush vegetation types have not taken big sagebrush taxonomy to the variety level, and big sagebrush taxonomy was refined after many of the classifications were done. These factors complicate the comparison of this plant association to other big sagebrush vegetation types.

The ARTRV2/FEID-ELSP3 p.a. is probably similar to part of the very broad *Artemisia tridentata* / *Festuca idahoensis* h.t. described by Mueggler and Stewart (1980) in western Montana. That habitat type includes mostly subspecies *vaseyana*. Based on the associated species and enviromental setting described for that habitat type, it probably includes both variety *pauciflora* and variety *vaseyana*.

This plant association may also correspond to part of the drier phase of the *Artemisia tridentata* subspecies *vaseyana* / *Festuca idahoensis* h.t. described by Tweit and Houston (1980) on the Shoshone National Forest.

The "*Artemisia tridentata vaseyana* / *Festuca idahoensis* h.t." described by Tiedeman et al. (1987) in Middle Park, Colorado is a heavily grazed community that resembles the early seral stage of this plant association. That "habitat type" occurs on fine-loamy soils that receive about 15 to 20 inches precipitation. Those conditions are similar to the envirionmental setting of this plant association within the Upper Green River Basin Subsection.

E.U.I. CROSS REFERENCE

The following ecological types from the Bridger-East EUI are characterized by the ARTRV2/FEID-ELSP3 p.a.:

ARTRV2/FEID-ELSP3, Decram Family ET
ARTRV2/FEID-ELSP3, Bangston Family ET
ARTRV2/FEID-ELSP3, Cambern Family ET

Ecological types characterized by the ARTRV2/FEID-ELSP3 p.a. occur as major components in the following map units from the Bridger-East EUI:

3221 Sedimentary Terraces, Big Sagebrush - Shrubby Cinquefoil Complex

3224 Sedimentary Terraces, Big Sagebrush - Silver Sagebrush - Shrubby Cinquefoil Complex

3326 Sedimentary Moraines, Shrubby Cinquefoil - Big Sagebrush Complex

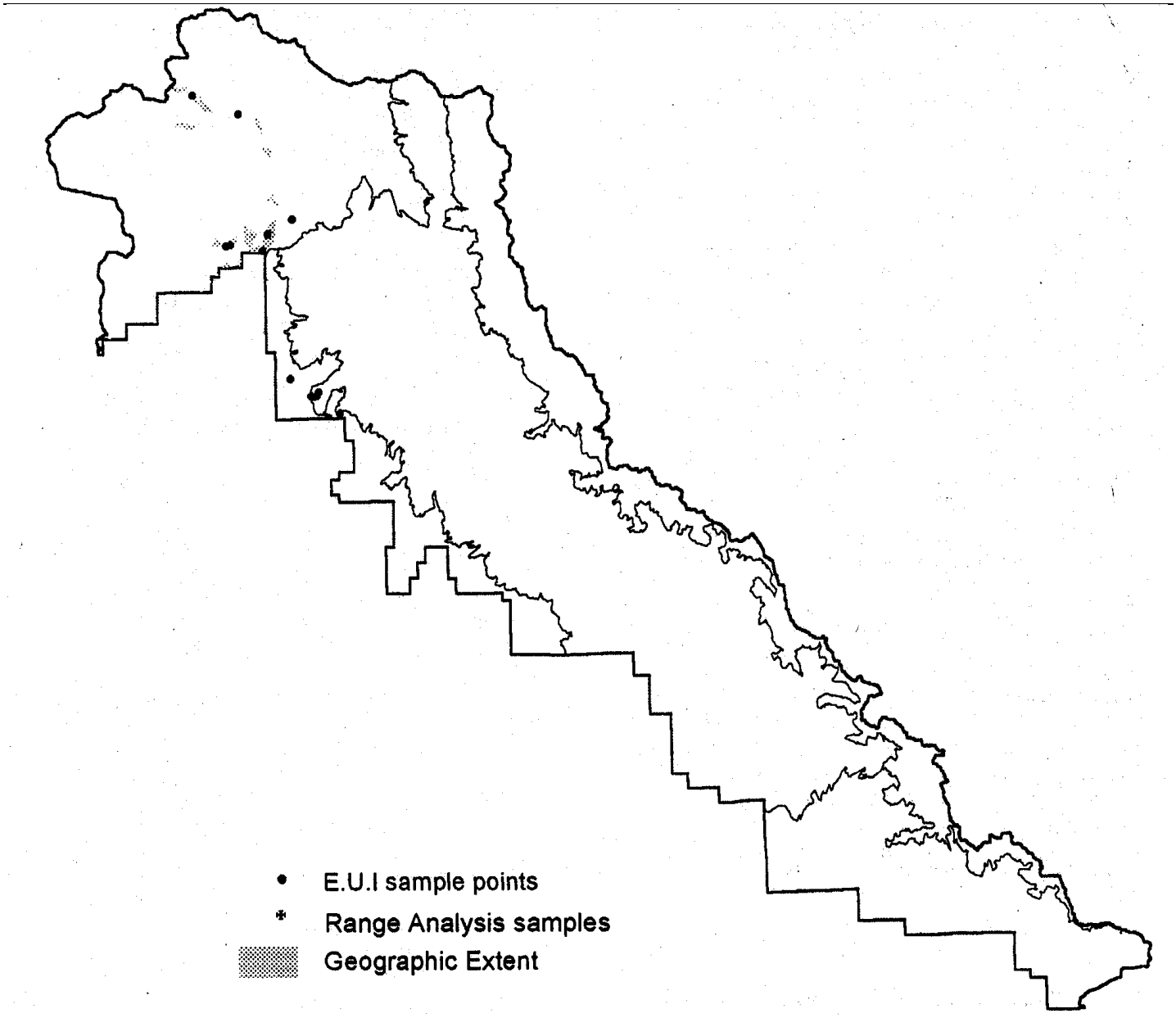
6334 Foothill Moraines, Aspen - Big Sagebrush - Shrubby Cinquefoil Complex

More detailed soil descriptions and more specific soil management interpretations are available in the ecological type and ecological map unit descriptions of the Bridger-East EUI.

"The trouble with trying to make yourself stupider than you really are is that you very often succeed."

C.S. Lewis

Vasey big sagebrush - mountain snowberry Subseries
Artemisia tridentata var. ***vaseyana - Symphoricarpos oreophilus*** Subseries
ARTRV2-SYOR2 Subseries



DISTRIBUTION AND EXTENT

The ARTRV2-SYOR2 Subseries occurs as a major landscape component fron Bacon Ridge south to Gypsum Hill in the Union Pass Uplands Subsection. It has a geographic extent of about 2,900 acres and occupies about 700 acres within that area. It also occurs in minor amounts from New Fork Lakes south to Willow Lake in the Upper Green River Basin Subsection.

ENVIRONMENT

Landforms: Mostly backslopes, shoulders, and summits of glacial moraines and till-mantled mountain slopes. Occasionally on nonglaciated mountain ridges.

Parent materials: Mostly glacial till or colluvium derived from mixed sedimentary and granitic materials. Also colluvium or residuum derived from sedimentary materials, or glacial till derived from granitic materials.

n=14	Mean	Observed Range
Elevation (ft)	8321	7900 - 8980
Annual Precip. (in)	23	16 - 28
Slope (%)	23	6 - 43

Aspect: Predominantly south and east.

VEGETATION

Diagnostic Species: The ARTRV2-SYOR2 Subseries includes communities in which Vasey big sagebrush and mountain snowberry are each present with at least 5 percent cover. There is insufficient data available to subdivide this PNV type based on associated understory species, so it is referred to as a subseries rather than a plant association.

Shrubs: Vasey big sagebrush is usually dominant. Mountain snowberry is also well represented and sometimes codominates. They form a medium shrub layer 2 to 3 feet tall. Creeping Oregon-grape and green rabbitbrush are often present in small amounts.

Herbs: Idaho fescue and/or bluebunch wheatgrass dominate the herb layer in undisturbed stands. Other common herbs include slender wheatgrass, oneflower helianthella, Columbia needlegrass, and arrowleaf balsamroot.

Bluebunch wheatgrass is most abundant on southerly slopes while slender wheatgrass is most abundant on east-facing slopes. This may be a basis for subdividing this subseries into plant associations. However, more data would be needed to verify and characterize such subdivisions.

Production: No range analysis transects have been identified as this subseries.

Species Richness: The number of plant taxa per plot ($375m^2$) ranged from 18 to 44, with a mean of 32 across all seral stages. Late seral plots averaged 33 taxa present. This subseries ranked first out of ten PNV types in species richness. This is because this subseries usually occurs adjacent to aspen stands and often includes some species more typical of aspen communities than sagebrush communities.

SOILS

The ARTRV2-SYOR2 Subseries occurs mostly on deep, well drained soils with a gravelly sandy loam, silt loam, or loam surface. The subsoil layer ranges from fine-loamy to loamy-skeletal and usually includes a layer of clay accumulation. This subseries has also been observed on soils less than 40 inches deep to weathered rock.

The following table lists mean values for soil properties closely related to plant growth.

n=8 Mean		Range
Depth to Restrictive Layer (in)	45+	9 - 60+
Rooting Depth (in)	30	9 - 48
A.W.C. to 40 inches (in)	3.8	0.8 - 6.6
A.W.C. to rooting depth (in)	2.9	0.8 - 5.4

Available water capacity (A.W.C.) is higher where this subseries occurs as a landscape component. The following table lists soil attributes and the percentage of this subseries' areal extent over which they occur.

Attribute	Percent of Areal Extent
Depth to Restrictive Layer	
40 inches or more	100%
Particle Size Class of Subsoil	
Fine-loamy	100%
Drainage Class	
Well drained	100%
Clay Accumulation	
Argillic horizon present	100%

This subseries has been observed predominantly on the following soil families:

Fine-loamy, mixed Argic Pachic Cryoborolls
Loamy-skeletal, mixed Pachic Cryoborolls

ASSOCIATED VEGETATION

Within the Bridger-East EUI survey area, the ARTRV2-SYOR2 Subseries occurs in association only with aspen forests. In the Union Pass Uplands it is usually associated with the POTR5/THFE c.t.

SERAL STAGES

Seral stage is based on canopy cover of understory decreasers and increasers; it is not directly related to sagebrush cover. The following table compares the seral stages of this subseries in terms of canopy cover, ground cover, and environmental features.

	Late n=4	Mid n=4	Early n=6
Canopy Cover:			
Shrubs	31	40	25
Graminoids	48	43	22
Forbs	23	32	29
Cover Sum	112	119	82
Ground Cover:			
Basal Vegetation	9	11	8
Litter & Wood	77	73	53
Moss & Lichen	1	0	1
Rock	7	9	21
Bare Soil	7	8	17
Environment:			
Slope (%)	25	25	17
Precipitation (in)	23	25	22
Elevation (ft)	8370	8370	8260
Aspect	S,E	E,S	E,W,S

ARTRV2-SYOR2 Subseries Plant Community Composition (n=14)

Common Name	Code	Late Seral[1] n = 4 Const	Late Seral[1] n = 4 Cover	Mid Seral n = 4 Const	Mid Seral n = 4 Cover	Early Seral n = 6 Const	Early Seral n = 6 Cover	Ecological Role
Shrubs:								
Vasey big sagebrush	ARTRV2 **	100	22	100	24	100	17	Major climax increaser
Utah mountain snowberry	SYORU **	100	9	100	11	100	7	Major climax increaser
mountain big sagebrush	ARTRP4	25	Tr	25	10	-	-	Transition to drier p.a.
creeping Oregon-grape	BERE	50	Tr	50	3	67	1	Minor climax, rocky sites
green rabbitbrush	CHVI8	50	Tr	25	4	67	Tr	Minor climax increaser
rose	ROSA5	25	Tr	25	1	17	1	Minor climax increaser
Perennial Grasses:								
Columbia needlegrass	STNE3	100	3	75	3	83	3	Minor climax decreaser
Idaho fescue	FEID *	75	25	75	19	67	11	Major climax decreaser
bluebunch wheatgrass	ELSP3 *	75	25	50	11	83	4	Major climax decreaser
nodding brome	BRAN	75	2	50	4	33	1	Minor climax decreaser
prairie Junegrass	KOMA	75	1	50	1	50	1	Minor climax decreaser
Letterman's needlegrass	STLE4	50	8	25	10	33	2	Minor climax increaser
slender wheatgrass	ELTR7	50	6	100	3	50	2	Minor climax decreaser
Canby's bluegrass	POSEE	50	2	50	1	33	2	Minor climax decreaser
mountain brome	BRCA5	25	5	75	2	17	1	Minor climax decreaser
King's spikefescue	HEKI	25	1	25	8	-	-	On rocky microsites
mutton bluegrass	POFE	25	1	25	Tr	17	2	Minor climax decreaser
oniongrass	MEBU	25	Tr	25	1	17	Tr	Minor climax decreaser
purple oniongrass	MESP	25	Tr	25	Tr	17	Tr	Transition to moister p.a.
Cusick's bluegrass	POCU3	-	-	50	2	17	Tr	Minor climax decreaser
needle-and-thread	STCO4	-	-	25	4	17	1	Minor climax increaser
bottlebrush squirreltail	ELEL5	-	-	25	Tr	50	1	Minor climax increaser
Kentucky bluegrass	POPR	-	-	-	-	17	10	Transition to moister site
Annual Grasses:								
cheatgrass brome	BRTE	-	-	-	-	17	23	Alien increaser
Sedges and Rushes:								
sedge	CAREX	50	Tr	50	5	67	2	Minor climax increaser
obtuse sedge	CAOB4	-	-	25	1	17	2	Minor climax increaser
Ross' sedge	CARO5	-	-	-	-	33	Tr	Minor climax increaser
Perennial Forbs:								
oneflower helianthella	HEUN *	100	8	75	4	50	6	Minor Climax
sulphur buckwheat	ERUM	100	4	100	7	83	4	Increases on bared soil
arrowleaf balsamroot	BASA3	100	3	25	Tr	100	3	Minor climax decreaser
Indian paintbrush	CASTI2	100	1	25	2	67	1	Minor climax
rockcress	ARABI2	100	Tr	75	Tr	17	Tr	Minor climax
aster	ASTER	75	4	100	5	67	1	Minor climax increaser
lupine	LUPIN	75	1	100	2	83	3	Minor climax increaser
western gromwell	LIRU4	75	Tr	-	-	33	Tr	Minor climax increaser
western yarrow	ACMIL3	25	Tr	75	2	67	1	Minor climax increaser
pussytoes	ANTEN	25	Tr	50	6	50	12	Increases on bared soil
northwest cinquefoil	POGR9	50	2	75	3	50	1	Minor climax increaser
sticky geranium	GEVI2	50	1	75	2	67	2	Transition to moister p.a.
milkvetch	ASTRA	50	1	50	2	17	1	Minor climax increaser
ballhead sandwort	ARCO5	50	1	25	2	67	1	Increases on bared soil
skyrocket gilia	IPAG	50	Tr	50	1	67	1	Minor climax
groundsel	SENEC	50	Tr	50	Tr	50	2	Minor climax
pale bastard toadflax	COUMP2	25	1	25	Tr	83	2	Minor climax increaser
strawberry	FRAGA	25	Tr	50	4	-	-	Minor climax increaser
hawksbeard	CREPI	25	Tr	25	Tr	83	1	Minor climax decreaser
flowery phlox	PHMU3	-	-	75	4	17	5	Increases on bared soil

** = Diagnostic species. * = Character species.

1. Seral stage is based on cover of understory decreasers and increasers; it is not directly related to sagebrush cover.

The table above (p.46) indicates that environmental conditions are fairly uniform across seral stages except for aspect and the amount of rock on the soil surface. This limited data suggests that the major effects of disturbance on the ARTRV2-SYOR2 Subseries include decreases in grass cover total canopy cover, and litter; and an increase in the amount of bare soil.

MANAGEMENT IMPLICATIONS

Fire Response: Vasey big sagebrush communities have a natural fire frequency between 20 and 40 years (Winward 1991). Presettlement fires burned unevenly leaving islands and stringers of sagebrush unburned during any one fire. Fire intensity varied in the areas that did burn. The result of such fires was an ever changing mosaic of different densities and ages of sagebrush plants, ranging from recently burned, open grasslands to very dense sagebrush stands that had not burned in a long time (Winward 1991).

The seeds of Vasey big sagebrush are stimulated to germinate by the heat of a fire (Champlin and Winward 1982; Hironaka *et al*. 1983; Crane and Fischer 1986). After a burn it can recover to 20 percent canopy cover in as little as 12 years (Winward 1991). In the absence of fire Vasey big sagebrush continues to increase in density and cover, and may reach canopy cover values as high as 45 percent. If sagebrush canopy cover exceeds 20 percent for a long period of time, the density, cover, and biomass of herbaceous species will be reduced through shading and competition for moisture. A 10 to 20 year cycle of sagebrush removal or thinning may be needed to maintain natural amounts of grasses and forbs in this subseries (Hironaka *et al*. 1983).

Mountain snowberry is a rhizomatous shrub which can spread rapidly (Mozingo 1987). After fire it sprouts from buds on root crowns and rhizomes, and usually rapidly returns to preburn cover levels (Fisher and Clayton 1983). However, its carbohydrate reserves are depleted to a low level during initiation of spring growth (Willard and McKell 1978), so it may recover more slowly after an early spring burn.

Idaho fescue and bluebunch wheatgrass can both be severely damaged by hot summer fires. Bluebunch wheatgrass can also be damaged by a spring burn, between green up and flowering, when its root reserves are lowest. Both grasses can increase following the removal of sagebrush by a cool fire. For best results, a burned area should be rested from grazing for two growing seasons. Severely depleted stands may not improve even with rest because the sparse understory provides very little competition for new sagebrush seedlings. Under these conditions the understory cannot recover significantly by the time sagebrush canopy cover returns to preburn levels. In such cases shrub density may increase many-fold following a fire (Hironaka *et al*. 1983).

Big Game Habitat: This subseries provides important foraging areas for elk and deer. It is a minor component of elk winter range and calving habitat on the Pinedale Ranger District. Idaho fescue and bluebunch wheatgrass are highly preferred by elk and moderately preferred by deer. Mountain snowberry is moderately preferred by both. Vasey big sagebrush is an important food source for deer and elk in fall and winter, but is rarely used in spring and summer. Any shrub removal or thinning should be done in a mosaic pattern to maintain winter browse while increasing herbaceous production.

Livestock Production: Idaho fescue, slender wheatgrass and bluebunch wheatgrass are the principle forage species in this subseries. They are all highly preferred by cattle and moderately preferred by sheep. Mountain snowberry is moderately preferred by sheep, but rarely used by cattle. This subseries often occurs on steep slopes which restrict livestock access.

Response to Grazing: Heavy grazing will decrease the amounts of Idaho fescue, slender wheatgrass, bluebunch wheatgrass, and Columbia needlegrass. Species that increase with overgrazing include bottlebrush squirreltail, Letterman's needlegrass, pussytoes, sulphur buckwheat, dryland sedges, and mountain snowberry.

Bluebunch wheatgrass is highly susceptible to damage from spring grazing, which depletes its root reserves and prevents it from producing seed. Repeated spring grazing can eliminate it from an area in a few years (USDA Forest Service 1937). To maintain bluebunch wheatgrass, grazing should be deferred until after seed set at least every third year. This may be difficult to achieve in areas that are used by wildlife in the spring.

Heavy grazing of the understory species can enhance the natural tendency of Vasey big sagebrush to increase in density and cover in two ways. First, by reducing competition from grasses and forbs. Second, by reducing fine fuels and thereby reducing the spread of wildfires. This increases the interval between fires and allows sagebrush cover to increase for a longer period of time.

Revegetation: The herbaceous layer of this subseries can be severely reduced by competition from an overly dense sagebrush canopy (see Fire Response) and/or improper grazing. Stands with moderately depleted understories may be capable of natural revegetation with appropriate management. Such management must allow desirable plants to increase in vigor and produce seed, and then allow seedlings to become established. This may require rest from grazing or deferment of grazing until after seed set. If sagebrush cover is more than 20 percent, then some type of shrub removal will be needed to release the understory from competition (Winward 1991). Chemical or mechanical treatments will usually reduce sagebrush cover for a longer time period than prescribed burning because germination of Vasey big sagebrush seeds is stimulated by the heat of a fire.

Damage from rodent burrowing can also hamper natural revegetation. Rodent activity has been observed on about one third of the plots in this subseries.

Watershed: In late seral stands of this subseries the canopy cover sum ranges from 103 to 125 percent with a mean of 110 percent. Bare soil ranges from 5 to 10 precent. So in relatively undisturbed stands most, but not all, of the soil surface is protected from rain drop impact and surface runoff. In early seral stands the cover sum is

between 58 and 96 percent, with a mean of 82 percent. Bare soil ranges from 10 to 25 percent. Improper grazing, fire, and rodent activity reduce ground cover and expose more of the soil surface to rain drop impact and surface runoff. Stands with more than 20 percent bare soil are at risk of soil loss, which could lower site potential. This risk is greater on steeper slopes.

Much of the precipitation received by this subseries falls as snow and is subject to loss through sublimation and removal by wind. A shrub canopy helps minimize these losses. On the south-facing slopes typical of this subseries, sagebrush removal may increase snow loss and reduce the available moisture on the site. However, total water consumption is lower on sites where sagebrush is removed (Knight 1994). It is possible that dense sagebrush stands produced by fire suppression and overgrazing have reduced deep infiltration, ground water supplies, and stream flows from presettlement levels. The hydrologic effects of sagebrush are more pronounced on deeper soils (Knight 1994).

COMPARISON TO OTHER STUDIES

Most classifications of sagebrush vegetation types have not taken big sagebrush taxonomy to the variety level, and big sagebrush taxonomy was refined after many of the classifications were done. These factors complicate the comparison of this plant association to other big sagebrush vegetation types.

This subseries may partially correspond to the *Artemisia tridentata* spp. *vaseyana* / *Symphoricarpos oreophlius* c.t. described by Tweit and Houston (1980) on the Shoshone National Forest. That community type occurs on south and west aspects on glacial till derived from sedimentary parent materials.

This subseries is also similar to part of the *Artemisia vaseyana "spiciformis"* / *Bromus carinatus* h.t. described by Hironaka *et al*. (1983) in southern Idaho. That habitat type is dominated mostly by *Artemisia tridentata* var. *vaseyana* and usually includes mountain snowberry.

E.U.I. CROSS REFERENCE

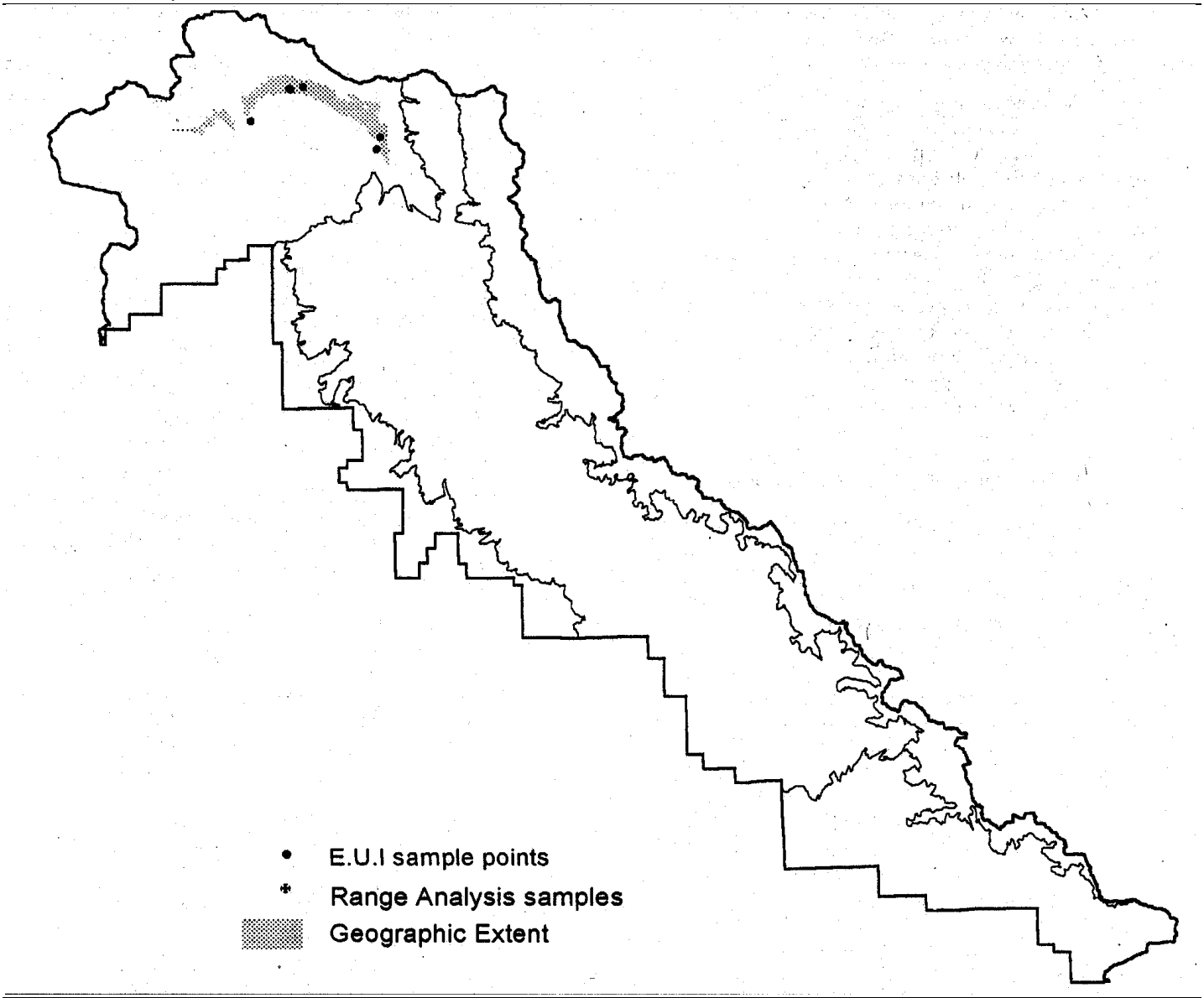
The ARTRV2-SYOR2 Subseries is used to characterize the potential natural vegetation of the ARTRV2-SYOR2, Cambern Family ET. This ecological type occur as major landscape component in the following map unit:

3631 Sedimentary Sideslopes, Aspen - Big Sagebrush Complex

More detailed soil descriptions and more specific soil management interpretations are available in the ecological type and map unit descriptions of the Bridger-East EUI.

"If you are on the wrong road, progress means doing an about-turn and walking back to the right road."
C.S. Lewis

Vasey big sagebrush / Richardson's needlegrass Plant Association
Artemisia tridentata var. ***vaseyana* / *Stipa richardsonii*** p.a.
ARTRV2/STRI2 p.a.



DISTRIBUTION AND EXTENT

The ARTRV2/STRI2 p.a. occurs as a major landscape component from Dollar Lake east to Green River Lakes in the Union Pass Uplands Subsection. It has a geographic extent of about 9,300 acres and occupies about 2,000 acres within that area. Similar plant communities have also been observed in the Gros Ventre River drainage (Bramble-Brodahl 1978).

ENVIRONMENT

Landforms: Backslopes and benches on glacial moraines and till-mantled mountain slopes, and outwash terraces.

Parent materials: Glacial till or glacial outwash derived from mixed granitic and sedimentary materials.

n=7	Mean	Observed Range
Elevation (ft)	8067	7800 - 8230
Annual Precip. (in)	24	23 - 25
Slope (%)	11	2 - 36

Aspect: Mostly north and west.

VEGETATION

Diagnostic Species: The ARTRV2/STRI2 p.a. includes communities which have at least 5 percent cover of Vasey big sagebrush and at least 5 percent cover of Richardson's needlegrass.

VEGETATION

Shrubs: Vasey big sagebrush is the dominant shrub and forms a medium shrub layer 2 to 3 feet tall. Shrubby cinquefoil and rose are occasionally present in small amounts.

Herbs: The herb layer is dominated by Idaho fescue or Richardson's needlegrass. Whether Richardson's needlegrass dominates due solely to site conditions or, at least in part, due to past disturbance is uncertain. Richardson's needlegrass occurs on sites with a period of poor soil aeration (Bramble-Brodahl 1978), so its abundance may reflect soil moisture conditions. Other common herbs in this association include timber oatgrass, pussytoes, lupine, and sulphur buckwheat.

Production: No range analysis transects have been identified in this plant association. However, its total annual production may be similar to that of the ARTRV2/ELTR7 p.a.

Species Richness: The number of plant taxa per plot ($375m^2$) ranges from 14 to 26, with a mean of 21 across all seral stages. Late seral plots average 22 taxa present. This plant association ranked tenth out of ten in species richness.

SOILS

This plant association occurs on deep, well drained soils. Surface textures range from loams to bouldery sandy loams. The subsoil is typically loamy-skeletal. There is sometimes a root and water restricting layer within 40 inches of the surface. This might be related to the brief period of soil saturation described by Bramble-Brodahl (1978).

The following table lists soil attributes and the percentage of this plant association's areal extent over which those attributes occur.

Attribute	Percent of Areal Extent
Depth to Restrictive Layer	
40 inches or more	64%
Less than 40 inches	36%
Particle Size Class of Subsoil	
Loamy-skeletal	100%
Drainage Class	
Well drained	100%
Clay Accumulation	
Argillic horizon present	36%
No argillic horizon	64%

The following table lists the mean values for properties closely related to plant growth.

n = 4	Mean	Range
Depth to Restrictive Layer (in)	40+	21 - 60+
Rooting Depth (in)	23	18 - 28
A.W.C. to 40 inches (in)	2.6	1.9 - 3.7
A.W.C. to rooting depth (in)	1.9	1.3 - 2.8

This plant association predominantly occurs on the following soil families:

Loamy-skeletal, mixed Typic Cryoborolls
Loamy-skeletal, mixed Argic Pachic Cryoborolls

ASSOCIATED VEGETATION

Within the Bridger-East EUI survey area, the ARTRV2 /STRI2 p.a. occurs in association with riparian communities dominated by shrubby cinquefoil and other Vasey big sagebrush plant associations. The table below lists the PNV types that occur as major landscape components within the geographic extent of the ARTRV2 /STRI2 p.a. and the area over which each PNV type is also a component.

Associated PNV	Acres in Association	Percent Co-occurrence
POFR4/FEID c.t.	5,960	64%
ARTRV2/FEID-ELSP3 p.a.	5,960	64%
POFR4/DECE c.t.	3,330	36%
ARTRV2/ELTR7 p.a.	3,330	36%

SERAL STAGES

Seral stage is based on canopy cover of understory decreasers and increasers; it is not directly related to sagebrush cover. The following table compares the seral stages of this association in terms of canopy cover, ground cover, and environmental features.

	Late n=3	Mid n=4	Early n=0
Canopy Cover:			
Shrubs	27	25	
Graminoids	57	53	
Forbs	17	18	
Cover Sum	105	97	
Ground Cover:			
Basal Vegetation	11	9	
Litter & Wood	66	67	
Moss & Lichen	7	14	
Rock	7	7	
Bare Soil	10	3	
Environment:			
Slope (%)	8	13	
Precipitation (in)	24	25	
Elevation (ft)	8077	8060	
Aspect	N,E, W		N,W,S

ARTRV2/STRI2 p.a. Plant Community Composition (n=7)

Common Name	Code	Late Seral[1] n = 3 Const	Late Seral[1] n = 3 Cover	Mid Seral n = 4 Const	Mid Seral n = 4 Cover	Early Seral n = 0 Const	Early Seral n = 0 Cover	Ecological Role
Shrubs:								
Vasey big sagebrush	ARTRV2 **	100	27	100	24	-	-	Major climax increaser
rose	ROSA5	33	Tr	25	Tr	-	-	Minor climax increaser
shrubby cinquefoil	POFR4	33	1	25	Tr	-	-	Transition to wetter sites
kinnikinnick	ARUV	-	-	50	4	-	-	Transition to forest sites
green rabbitbrush	CHVI8	-	-	25	Tr	-	-	Major climax increaser
common juniper	JUCOD	-	-	25	Tr	-	-	Transition to forest sites
Perennial Grasses:								
Richardson's needlegrass	STRI2 **	100	23	100	33	-	-	Major climax increaser
Idaho fescue	FEID *	100	20	75	3	-	-	Major climax decreaser
timber oatgrass	DAIN *	100	3	75	4	-	-	Transition to wetter sites
Letterman's needlegrass	STLE4	67	8	-	-	-	-	Minor climax increaser
bottlebrush squirreltail	ELEL5	67	Tr	100	1	-	-	Minor climax increaser
Sandberg bluegrass	POSES#	33	4	-	-	-	-	Minor climax increaser
prairie Junegrass	KOMA	33	2	100	4	-	-	Minor climax decreaser
nodding brome	BRAN	33	1	50	1	-	-	Minor climax decreaser
Cusick's bluegrass	POCU3	33	2	25	1	-	-	Minor climax decreaser
bluegrass	POA	33	2	-	-	-	-	Minor climax decreaser
needle-and-thread	STCO4	33	2	-	-	-	-	Minor climax increaser
bentgrass	AGROS2	-	-	50	3	-	-	Transition to wetter sites
alkali bluegrass	POJU	-	-	50	2	-	-	Minor climax decreaser
Columbia needlegrass	STNE3	-	-	50	2	-	-	Minor climax decreaser
slender wheatgrass	ELTR7	-	-	25	Tr	-	-	Minor climax decreaser
Sedges and Rushes:								
obtuse sedge	CAOB4	67	2	25	1	-	-	Minor climax increaser
sedge	CAREX	33	2	50	5	-	-	Minor climax increaser
dryland sedge	CAXE	-	-	25	3	-	-	Minor climax increaser
Perennial Forbs:								
pussytoes	ANTEN	100	4	100	7	-	-	Increases on bared soil
lupine	LUPIN	100	4	75	3	-	-	Minor climax increaser
sulphur buckwheat	ERUM	100	2	100	3	-	-	Increases on bared soil
Hood's phlox	PHHO	100	2	100	1	-	-	Increases on bared soil
silene	SILEN	100	Tr	25	Tr	-	-	Minor climax increaser
prairiesmoke	GETR	67	2	100	2	-	-	Minor Climax Increaser
strawberry	FRAGA	67	2	-	-	-	-	Minor Climax Increaser
pleated gentian	GEAF	67	1	-	-	-	-	Minor Climax
western yarrow	ACMIL3	67	1	-	-	-	-	Minor climax increaser
green gentian	SWRA	67	1	-	-	-	-	Minor climax
Indian paintbrush	CASTI2	67	Tr	75	Tr	-	-	Minor Climax
rockcress	ARABI2	67	Tr	75	Tr	-	-	Minor Climax
timber milkvetch	ASMI9	33	3	25	4	-	-	Minor climax increaser
lousewort	PEDIC	33	Tr	25	1	-	-	Minor climax increaser
ballhead sandwort	ARCO5	33	Tr	25	Tr	-	-	Increases on bared soil
sticky geranium	GEVI2	33	Tr	-	-	-	-	Transition to moister p.a.
flowery phlox	PHMU3	-	-	25	1	-	-	Increases on bared soil
dock	RUMEX	-	-	25	Tr	-	-	Minor climax increaser
Annual Forbs:								
owlclover	ORTHO	67	2	50	3	-	-	Minor climax increaser
annual gentian	GEAM3	-	-	25	1	-	-	Minor climax increaser
starwort	STELL	-	-	25	1	-	-	Minor climax increaser

** = Diagnostic species. * = Character species.

1. Seral stage is based on cover of understory decreasers and increasers; it is not directly related to sagebrush cover.

Environmental conditions appear similar across seral stages. There is insufficient data to fully describe the effects of disturbance on this plant association.

MANAGEMENT IMPLICATIONS

Fire Response: Vasey big sagebrush plant associations have a natural fire frequency between 20 and 40 years (Winward 1991). Presettlement fires burned unevenly leaving islands and stringers of sagebrush unburned during any one fire. Fire intensity varied in the areas that did burn. The result of such fires was an ever changing mosaic of different densities and ages of sagebrush plants, ranging from recently burned, open grasslands to very dense sagebrush stands that had not burned in a long time (Winward 1991).

The seeds of Vasey big sagebrush are stimulated to germinate by the heat of a fire (Champlin and Winward 1982; Hironaka *et al*. 1983; Crane and Fischer 1986). After a burn it can recover to 20 percent canopy cover in as little as 12 years (Winward 1991). In the absence of fire Vasey big sagebrush continues to increase in density and cover, and may reach canopy cover values as high as 30 percent in this association. It does not appear to increase as rapidly or as much in this plant association as in other Vasey big sagebrush associations.

Idaho fescue can be severely damaged by hot summer or fall fires. Grasses can increase in this plant association following removal of sagebrush by a cool fire. For best results, a burned area should be rested from grazing for two growing seasons. This may be difficult in areas of heavy wildlife use. Rest from grazing immediately after a burn allows grass plants to increase in vigor and produce seed while competition from sagebrush is lowest.

Big Game Habitat: This plant association provides summer and fall foraging areas for elk, deer, moose, and pronghorn antelope. It also occurs in areas of crucial elk winter range north of Green River Lakes.

Livestock Production: Idaho fescue is the principle forage species in this plant association. It is highly preferred by cattle and moderately preferred by sheep. Richardson's needlegrass appears to receive no grazing use at all. Livestock access is only occasionally limited by steep slopes.

Response to Grazing: Grasses that decrease with overgrazing include Idaho fescue, prairie junegrass, and Cusick's bluegrass. Herbs that increase with overgrazing include Richardson's needlegrass, pussytoes, sulphur buckwheat, lupine, bottlebrush squirreltail, and prairiesmoke.

Revegetation: Stands with severely depleted understories have not been observed in this plant association, so revegetation may not be a major concern. The main effects of overgrazing appear to be a decrease in Idaho fescue and an increase in Richardson's needlegrass. There little net change in canopy cover or ground cover. This may be because Richardson's needlegrass does not attract heavy use by livestock or wildlife. It is uncertain whether Idaho fescue can replace Richardson's needlegrass once it is established.

Sagebrush appears to increase slowly in this association for two possible reasons. First, the herbaceous layer appears to compete well with sagebrush seedlings, even after overgrazing. Second, a brief period of soil saturation in some years may periodically kill sagebrush seedlings.

When sagebrush cover is more than 20 percent, some type of shrub removal may be needed to release the understory from competition (Winward 1991) if increased herbaceous production is desired. Chemical or mechanical treatments may reduce sagebrush cover for a longer time period than prescribed burning because germination of Vasey big sagebrush seeds is stimulated by the heat of a fire.

Watershed: In late seral stands of this plant association the canopy cover sum ranges from 94 to 119 percent, with a mean of 105 percent. Bare soil ranges from 5 to 20 percent. So in relatively undisturbed stands, most but not all of the soil surface is protected from rain drop impact and most of the surface is protected from runoff. In mid seral stands the cover sum ranges from 86 to 113 percent, with a mean of 97 percent. Bare soil ranges from 0 to 10 percent. Improper grazing and fire may reduce ground cover and expose more of the soil surface to rain drop impact and surface runoff. Stands with more than 20 percent bare soil are at risk of soil loss, which could lower site potential.

Much of the precipitation received by this plant association falls as snow and is subject to loss through sublimation and removal by wind. A shrub canopy helps minimize these losses. However, total water consumption is lower on sites where sagebrush is removed (Knight 1994).

COMPARISON TO OTHER STUDIES

Most classifications of sagebrush vegetation types have not taken big sagebrush taxonomy to the variety level, and big sagebrush taxonomy was refined after many of the classifications were done. These factors complicate the comparison of this plant association to other big sagebrush vegetation types.

The understory of this plant association is somewhat similar to that of the *Artemisia tridentata vaseyana* / *Stipa comata - Geum triflorum* habitat type, *Stipa richarsonii* phase described by Bramble-Brodahl (1978) in the Gros Ventre River drainage. However, this plant association contains very little needle-and-thread. "*Artemisia tridentata vaseyana*" is synonymous with *A. tridentata* var. *pauciflora,* not variety *vaseyana.*

E.U.I. CROSS REFERENCE

The ARTRV2/STRI2 p.a. forms part of the potential natural vegetation in the following ecological types from the Bridger-East EUI:

ARTRV2/ELTR7, Decram Family ET
ARTRV2/ELTR7, Keman Family ET

The above ecological types are characterized by the ARTRV2/STRI2 p.a. in the following map units:

3326 Sedimentary Moraines, Shrubby Cinquefoil - Big Sagebrush Complex

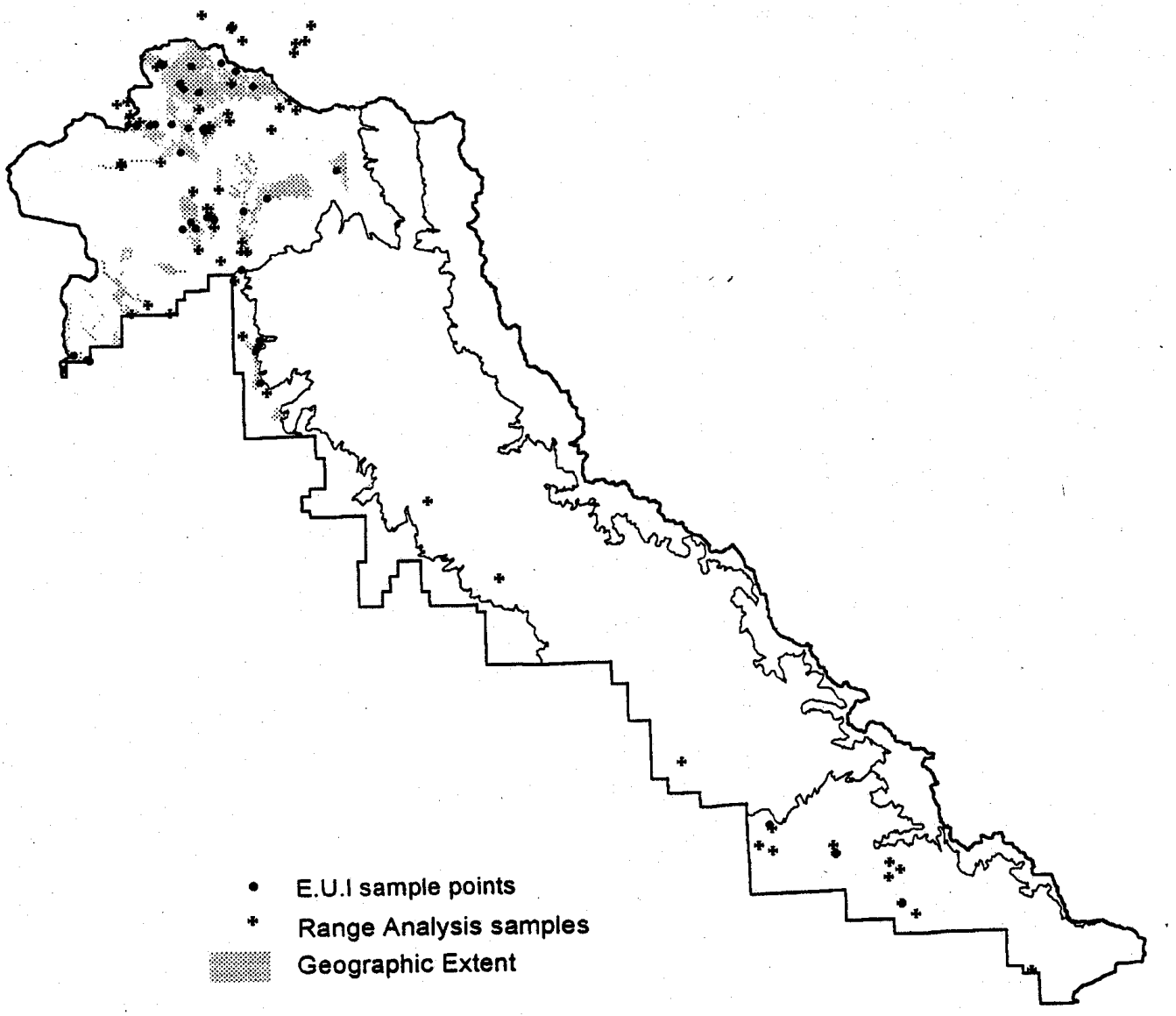
3327 Sedimentary Moraines, Big Sagebrush - Shrubby Cinquefoil Complex

The above ecological type and map unit descriptions include more detailed soil descriptions and specific soil management interpretations for this plant association.

"My son, be warned: the writing of many books is endless, and excessive devotion to books is wearying to the body."

Solomon

Vasey big sagebrush / **slender wheatgrass** Plant Association
Artemisia tridentata var. ***vaseyana*** / ***Elymus trachycaulus*** p.a.
ARTRV2/ELTR7 p.a.



DISTRIBUTION AND EXTENT

The ARTRV2/ELTR7 p.a. occurs as a major landscape component from Mosquito Lake south to The Rim and east to Green River Lakes and Gypsum Creek in the Union Pass Uplands Subsection. It also a major component from Boulder Basin to Willow Lake in the Upper Green River Basin Subsection. It also occurs in minor amounts in the Subsummit Uplands and Southeastern Wind River Mountains Subsections. It has a geographic extent of about 36,100 acres and occupies about 11,100 acres within that area. The following table lists the geographic and areal extents of this plant association by subsection.

Subsection	Geographic Extent	Areal Extent
Union Pass Uplands	34,700	10,600ac
Upper Green River Basin	1,400ac	500ac

ENVIRONMENT

Landforms: Sideslopes and crests of glacial moraines and till-mantled mountain slopes, and alluvial or outwash terraces.

Parent materials: Mostly glacial till or alluvium derived from sedimentary materials or mixed sedimentary and granitic materials; or alluvium derived from quartzite conglomerates.

n=100	Mean	Observed Range
Elevation (ft)	8574	7800 - 9600
Annual Precip. (in)	25	19 - 31
Slope (%)	13	0 - 60

Aspect: Mostly south, east, and west.

VEGETATION

Diagnostic Species: The ARTRV2/ELTR7 p.a. includes communities in which Vasey big sagebrush cover is at least 5 percent, and slender wheatgrass and northwest cinquefoil total at least 5 percent cover.

Shrubs: Vasey big sagebrush is usually the only shrub present and forms a medium shrub layer 2 to 3 feet tall.

Herbs: Idaho fescue dominates the herb layer, and slender wheatgrass is often codominant. Northwest cinquefoil, Columbia needlegrass, sulphur buckwheat, pussytoes, western yarrow, and prairiesmoke are also common.

Production: Total annual production (current year's growth of shrubs and herbs) averaged 1000 lbs/acre on 60 range analysis transects, with a typical range of 450 to 1600 lbs/acre. This range reflects variation in environmental factors and annual climatic variation as well as the effects of disturbance. The range analysis transects were sampled between 1961 and 1982. They are on file at the Pinedale Ranger District.

Species Richness: The number of plant taxa per plot ($375m^2$) ranged from 11 to 38, with a mean of 27 across all seral stages. Late seral plots also averaged 32 taxa present. This plant association ranked third out of ten in species richness.

SOILS

This plant association predominantly occurs on deep, well drained soils. It has also been observed on soils that are moderately deep to bedrock. Surface textures range from silt loams to gravelly sandy loams. The subsoil layer is loamy-skeletal, coarse-loamy, or fine-loamy.

The following table lists soil attributes and the percentage of this plant association's areal extent over which those attributes occur.

Attribute	Percent of Areal Extent
Depth to Restrictive Layer	
40 inches or more	81%
Less than 40 inches	19%
Particle Size Class of Subsoil	
Loamy-skeletal	63%
Coarse-loamy	19%
Fine-loamy	18%
Drainage Class	
Well drained	100%
Clay Accumulation	
Argillic horizon present	38%
No argillic horizon	62%

The following table lists the mean values for properties closely related to plant growth.

n = 31	Mean	Range
Depth to Restrictive Layer (in)	57+	25 - 64+
Rooting Depth (in)	27	6 - 63
A.W.C. to 40 inches (in)	4.0	2.1 - 6.4
A.W.C. to rooting depth (in)	3.0	0.7 - 9.2

This plant association predominantly occurs on the following soil families:

Loamy-skeletal, mixed Typic Cryoborolls
Coarse-loamy, mixed Pachic Cryoborolls
Fine-loamy, mixed Mollic Cryboralfs
Loamy-skeltal, mixed Argic Pachic Cryoborolls
Loamy-skeletal, mixed Mollic Cryoboralfs

ASSOCIATED VEGETATION

Within the Bridger-East EUI survey area, the ARTRV2 /ELTR7 p.a. occurs in association mostly with riparian communities dominated by mountain silver sagebrush and shrubby cinquefoil. The table below lists the PNV types that occur as major landscape components within the geographic extent of the ARTRV2 /ELTR7 p.a. and the area over which each PNV type is also a component.

Associated PNV	Acres in Association	Percent Co-occurrence
POFR4/FEID c.t.	15,570	57%
ARCAV2/FEID c.t.	15,490	56%
ARCAV2/DECE c.t.	13,070	48%
POFR4/DECE c.t.	12,540	46%
ARTRV2/STRI2 p.a.	3,330	12%
SAWO/Mesic Forb c.t.	3,030	11%
ARTRV2/TRSP2 p.a.	2,450	9%
SABO2/CARO6 c.t.	2,450	9%
SAWO/DECE c.t.	1,350	5%
POTR5/SYOR2/BRCA5 c.t.	1,350	5%
PSME/BERE p.a.	1,350	5%

SERAL STAGES

Seral stage is based on canopy cover of understory decreasers and increasers; it is not directly related to sagebrush cover. The following table (p.58) compares the seral stages of this association in terms of canopy cover, ground cover, and environmental features. Environmental conditions appear similar across seral stages. The table indicates that the major effects of disturbance on this plant association include decreases in grass cover, total canopy cover, and litter; and increases in forb cover and bare soil.

ARTRV2/ELTR7 p.a. Plant Community Composition (n=40)

Common Name	Code	Late Seral[1] n = 6 Const	Late Seral[1] n = 6 Cover	Mid Seral n = 9 Const	Mid Seral n = 9 Cover	Early Seral n = 25 Const	Early Seral n = 25 Cover	Ecological Role
Shrubs:								
Vasey big sagebrush	ARTRV2 **	100	29	100	30	100	25	Major climax increaser
mountain big sagebrush	ARTRP4	-	-	-	-	4	5	Transition to drier p.a.
Perennial Grasses:								
Idaho fescue	FEID *	100	38	100	26	92	13	Major climax decreaser
Columbia needlegrass	STNE3	100	2	78	3	52	3	Minor climax decreaser
slender wheatgrass	ELTR7 **	83	5	89	3	84	4	Major climax decreaser
Letterman's needlegrass	STLE4	67	5	44	3	36	5	Minor climax increaser
prairie Junegrass	KOMA	67	2	67	2	56	2	Minor climax decreaser
alkali bluegrass	POJU	67	1	-	-	8	9	Minor climax decreaser
bottlebrush squirreltail	ELEL5	67	Tr	11	Tr	36	1	Minor climax increaser
timber oatgrass	DAIN	50	5	78	2	56	4	On wetter microsites
Cusick's bluegrass	POCU3	33	2	44	3	12	4	Minor climax decreaser
nodding brome	BRAN	33	1	56	1	12	2	Minor climax decreaser
mutton bluegrass	POFE	33	1	11	2	24	4	Minor climax decreaser
needle-and-thread	STCO4	33	1	-	-	12	11	Minor climax increaser
big bluegrass	POJUA	33	Tr	11	1	40	3	Minor climax decreaser
Canby's bluegrass	POSEE	17	Tr	44	3	16	7	Minor climax decreaser
Sedges and Rushes:								
dryland sedge	CAXE	67	2	11	1	32	2	Minor climax increaser
obtuse sedge	CAOB4	67	1	67	2	24	2	Minor climax increaser
sedge	CAREX	17	2	44	2	44	3	Minor climax increaser
threadleaf sedge	CAFI	17	2	-	-	28	15	Minor climax increaser
Raynolds' sedge	CARA6	17	Tr	11	Tr	8	Tr	Transition to moister p.a.
Perennial Forbs:								
sulphur buckwheat	ERUM	100	5	89	5	96	5	Increases on bared soil
pussytoes	ANTEN	83	3	89	4	92	5	Increases on bared soil
western yarrow	ACMIL3	83	2	78	1	60	1	Minor climax increaser
prairiesmoke	GETR	83	1	89	3	72	2	Minor climax increaser
northwest cinquefoil	POGR9 **	83	1	89	2	44	2	Minor climax
lupine	LUPIN	83	1	78	3	64	2	Minor climax increaser
green gentian	SWRA	83	1	67	1	56	1	Minor climax
ballhead sandwort	ARCO5	83	1	44	1	44	4	Increases on bared soil
rockcress	ARABI2	83	Tr	67	Tr	68	Tr	Minor climax
aster	ASTER	67	1	56	2	48	1	Minor climax increaser
groundsel	SENEC	67	Tr	56	1	20	2	Minor climax
pale agoseris	AGGL	50	4	22	1	16	1	Minor climax decreaser
flowery phlox	PHMU3	50	2	56	3	32	3	Increases on bared soil
sticky geranium	GEVI2	50	1	44	Tr	28	1	Transition to moister p.a.
blue flax	LILE3	50	1	11	Tr	12	1	Minor climax decreaser
fleabane	ERIGE2	50	Tr	44	1	56	2	Minor climax increaser
common dandelion	TAOF	33	1	44	Tr	64	1	Alien increaser
strawberry	FRAGA	33	Tr	33	1	20	2	Minor climax increaser
Hood's phlox	PHHO	17	1	56	1	36	2	Increases on bared soil
Indian paintbrush	CASTI2	-	-	11	2	40	1	Minor climax
elk thistle	CISC2	-	-	11	2	36	1	Minor climax increaser
Annual Forbs:								
pygmyflower rockjasmine	ANSES	67	Tr	44	Tr	36	1	Minor climax increaser
Douglas' knotweed	PODO4	50	Tr	11	Tr	24	3	Increases on bared soil
annual gentian	GEAM3	33	Tr	11	Tr	12	Tr	Minor climax
narrowleaf mountaintrumpet	COLI2	33	Tr	11	Tr	32	1	Increases on bared soil
whitlowgrass	DRABA	33	Tr	44	Tr	24	1	Increases on bared soil

** = Diagnostic species. * = Character species.

1. Seral stage is based on cover of understory decreasers and increasers; it is not directly related to sagebrush cover.

	Late n=6	Mid n=9	Early n=25
Canopy Cover:			
Shrubs	29	30	26
Graminoids	53	40	37
Forbs	18	24	22
Cover Sum	109	100	90
Ground Cover:			
Basal Vegetation	10	9	8
Litter & Wood	82	79	70
Moss & Lichen	1	1	3
Rock	2	6	6
Bare Soil	6	5	13
Environment:			
Slope (%)	5	9	5
Precipitation (in)	24	25	26
Elevation (ft)	8497	8483	8589
Aspect	W,S,E	S,E,N	E,W,N,S

MANAGEMENT IMPLICATIONS

Fire Response: Vasey big sagebrush plant associations have a natural fire frequency between 20 and 40 years (Winward 1991). Presettlement fires burned unevenly leaving islands and stringers of sagebrush unburned during any one fire. Fire intensity varied in the areas that did burn. The result of such fires was an ever changing mosaic of different densities and ages of sagebrush plants, ranging from recently burned, open grasslands to very dense sagebrush stands that had not burned in a long time (Winward 1991).

The seeds of Vasey big sagebrush are stimulated to germinate by the heat of a fire (Champlin and Winward 1982; Hironaka *et al*. 1983; Crane and Fischer 1986). After a burn it can recover to 20 percent canopy cover in as little as 12 years (Winward 1991). In the absence of fire Vasey big sagebrush continues to increase in density and cover, and may reach canopy cover values as high as 45 percent. If sagebrush canopy cover exceeds 20 percent for a long period of time, the density, cover, and biomass of herbaceous species will be reduced through shading and competition for moisture. Fire suppression over the last 80 years has allowed dense sagebrush canopies to develop over much of the area occupied by this plant association. A 20 to 40 year cycle of sagebrush removal or thinning is needed to maintain natural amounts of grasses and forbs in this plant association (Winward 1991).

Idaho fescue can be severely damaged by hot summer or fall fires. Grasses can increase in this plant association following removal of sagebrush by a cool fire. For best results, a burned area should be rested from grazing for two growing seasons. This may be difficult in areas of heavy wildlife use. Rest from grazing immediately after a burn allows grass plants to increase in vigor and produce seed while competition from sagebrush is lowest.

Big Game Habitat: This plant association provides summer and fall foraging areas for elk and deer, and occasionally moose or pronghorn antelope.

Livestock Production: Idaho fescue and slender wheatgrass are the principle forage species in this plant association. Both are highly preferred by cattle and moderately preferred by sheep. Livestock access is only occasionally limited by steep slopes.

Response to Grazing: Grasses that decrease with overgrazing include Idaho fescue, slender wheatgrass, Columbia needlegrass, prairie junegrass, and Cusick's bluegrass. Forbs generally increase with cattle grazing, but some species decrease with sheep use. These include northwest cinquefoil, groundsel, sticky geranium, and pale agoseris. Herbs that increase with overgrazing include western yarrow, sulphur buckwheat, pussytoes,Letterman's needlegrass, lupine, bottlebrush squirreltail, and prairiesmoke.

Heavy grazing of understory species can enhance the natural tendency of Vasey big sagebrush to increase in density and cover in two ways. First, by reducing competition from grasses and forbs. Second, by reducing fine fuels and thereby reducing the spread of wildfires. This increases the interval between fires and allows sagebrush cover to increase for a longer period of time.

Revegetation: The herbaceous layer of this plant association can be severely reduced by competition from overly dense sagebrush (see Fire Response) and/or improper grazing. Stands with moderately depleted understories may be capable of natural revegetation with appropriate management. To promote natural revegetation, management must allow the remaining desirable plants to increase in vigor and produce seed, and then allow seedlings to become established. This may require rest from grazing or deferment of grazing until after seed set. This may be difficult in areas used by wildlife.

If sagebrush cover is more than 20 percent, then some type of shrub removal will be needed to release the understory from competition (Winward 1991). Chemical or mechanical treatments may reduce sagebrush cover for a longer time period than prescribed burning because germination of Vasey big sagebrush seeds is stimulated by the heat of a fire.

Rodent burrowing is somewhat common in this plant association, especially in early seral stands. High levels of activity can severely hamper revegetation.

Watershed: In late seral stands of this plant association the canopy cover sum ranges from 103 to 116 percent, with a mean of 109 percent. Bare soil ranges from 3 to 10 percent. So in relatively undisturbed stands, nearly all of the soil surface is protected from rain drop impact and most of the surface is protected from runoff. In early seral stands the cover sum ranges from 46 to 123 percent, with a mean of 90 percent. Bare soil ranges from 0 to 60 percent, with a mean of 13 percent. Improper grazing, fire and rodent burrowing all reduce ground cover and expose more of the soil surface to rain drop impact and surface runoff. Stands with more than 20 percent bare soil are at risk of soil loss, which could lower site potential.

This risk is greater on steeper slopes.

Much of the precipitation received by this plant association falls as snow and is subject to loss through sublimation and removal by wind. A shrub canopy helps minimize these losses. However, total water consumption is lower on sites where sagebrush is removed (Knight 1994). It is possible that dense sagebrush stands produced by fire suppression and overgrazing have reduced deep infiltration, ground water supplies, and stream flows from presettlement levels. The hydrologic effects of sagebrush are more pronounced on deeper soils (Knight 1994).

COMPARISON TO OTHER STUDIES

Most classifications of sagebrush vegetation types have not taken big sagebrush taxonomy to the variety level, and big sagebrush taxonomy was refined after many of the classifications were done. These factors complicate the comparison of this plant association to other big sagebrush vegetation types.

This plant association is somewhat similar to the *Artemisia vaseyana spiciformis* / *Bromus carinatus* habitat type (h.t.) described by Hironaka *et al*. (1983) in southern Idaho. "*Artemisia vaseyana spiciformis*" is synonymous with *A. tridentata* var*. vaseyana.*

This plant association appears to be intermediate in composition and moisture to the two phases of the *Artemisia tridentata* / *Festuca idahoensis* h.t. described in western Montana by Mueggler and Stewart (1980). It lacks the bluebunch wheatgrass typical of their dry phase, but it also lacks the sticky geranium and Raynold's sedge typical of their moist *Geranium viscosissimum* phase.

E.U.I. CROSS REFERENCE

The ARTRV2/ELTR7 p.a. forms all or part of the potential natural vegetation in the following ecological types from the Bridger-East EUI:

ARTRV2/ELTR7, Amesmont Family ET
ARTRV2/ELTR7, Decram Family ET
ARTRV2/ELTR7, Keman Family ET
ARTRV2/ELTR7, Naz Family ET
ARTRV2-ARTRS2, Guiser Family ET

The above ecological types occur as major landscape components in the following map units:

3321 Sedimentary Till Plains, Shrubby Cinquefoil - Silver Sagebrush - Big Sagebrush Complex

3322 Sedimentary Till Plains, Big Sagebrush - Silver Sagebrush Complex

3323 Sedimentary Moraines, Big Sagebrush - Silver Sagebrush - Willow Complex

3324 Sedimentary Moraines, Big Sagebrush - Alkali Sagebrush Complex

3325 Sedimentary Moraines, Silver Sagebrush - Big Sagebrush - Willow Complex

3327 Sedimentary Moraines, Big Sagebrush - Shrubby Cinquefoil Complex

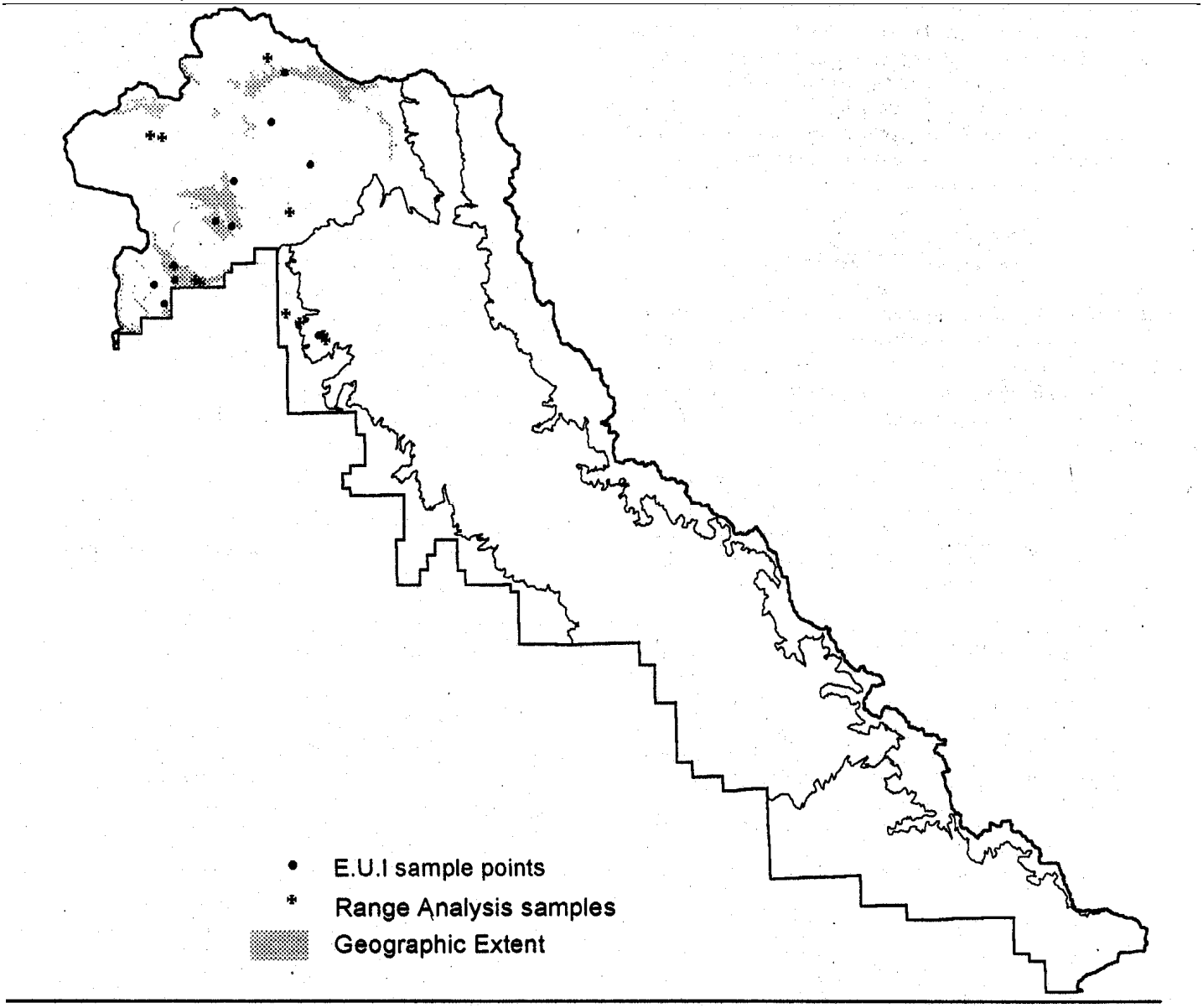
3520 Sedimentary Bottoms, Big Sagebrush - Willow - Silver Sagebrush Complex

3521 Sedimentary Bottoms, Big Sagebrush - Willow Complex

6621 Foothill Sideslopes, Big Sagebrush - Aspen - Douglas-fir Complex

"The human mind is of its own nature prone to suppose the existence of more order and regularity in the world than it finds."
Sir Francis Bacon

Vasey big sagebrush / spike trisetum Plant Association
Artemisia tridentata *var.* ***vaseyana*** */* ***Trisetum spicatum*** p.a.
ARTRV2/TRSP2 p.a.



DISTRIBUTION AND EXTENT

The ARTRV2/TRSP2 p.a. occurs as a major landscape component from the Gros Ventre Wilderness south to The Rim and east to Roaring Fork Basin in the Union Pass Uplands Subsection. It also occurs in minor amounts in the Subsummit Uplands and Upper Green River Basin Subsections. It has a geographic extent of about 16,600 acres and occupies about 4,200 acres within that area.

ENVIRONMENT

This is the coolest and wettest plant association in the ARTRV2 Series.

Landforms: Sideslopes of glacial moraines and till-mantled mountain slopes, sideslopes of non-glaciated mountains and ridges, and old alluvial terraces.

Parent materials: Glacial till, colluvium, or residuum derived from sedimentary materials (mostly sandstone, siltstone, and shale) mixed sedimentary and granitic materials; or alluvium and colluvium derived from quartzite conglomerates.

n=21	Mean	Observed Range
Elevation (ft)	8552	8100 - 9440
Annual Precip. (in)	26	20 - 31
Slope (%)	13	3 - 40

Aspect: Mostly south, east, and west.

VEGETATION

Diagnostic Species: The ARTRV2/TRSP2 p.a. includes communities in which Vasey big sagebrush cover is at least 5 percent, and spike trisetum, sticky geranium, purple oniongrass, and/or Raynold's sedge total at least 5 percent cover.

Shrubs: Vasey big sagebrush is dominant and forms a medium shrub layer 2 to 3 feet tall. Subalpine big sagebrush is sometimes present in moist microsites and indicates transition toward the cooler and wetter ARTRS2/TRSP2 p.a.

Herbs: Idaho fescue dominates the herb layer, and slender wheatgrass is often codominant. Northwest cinquefoil, sulphur buckwheat, western yarrow, and nodding brome are also common, in addition to the diagnostic species listed above.

Production: Total annual production (current year's growth of shrubs and herbs) averaged 2100 lbs/acre on 11 range analysis transects, with a typical range of 1400 to 2700 lbs/acre. The range transects were sampled between 1963 and 1983. They are on file at the Pinedale Ranger District.

Species Richness: The number of plant taxa per plot ($375m^2$) ranged from 19 to 38, with a mean of 29 across all seral stages. Late seral plots also averaged 29 taxa present. This plant association ranked second out of ten in species richness.

SOILS

This plant association predominantly occurs on deep, well drained soils. Surface textures are loams, sandy loams, silt loams, and gravelly loams. The subsoil layer is fine-loamy or loamy-skeletal. It has also been observed on soils that are shallow or moderately deep to bedrock.

The following table lists soil attributes and the percentage of this plant association's areal extent over which those attributes occur.

Attribute	Percent of Areal Extent
Depth to Restrictive Layer	
40 inches or more	100%
Particle Size Class of Subsoil	
Fine-loamy	62%
Loamy-skeletal	38%
Drainage Class	
Well drained	100%
Clay Accumulation	
Argillic horizon present	93%
No argillic horizon	7%

The table below lists the mean values for properties closely related to plant growth.

n = 9	Mean	Range
Depth to Restrictive Layer (in)	44+	14 - 60+
Rooting Depth (in)	26	8 - 39
A.W.C. to 40 inches (in)	4.0	1.7 - 5.6
A.W.C. to rooting depth (in)	3.2	1.0 - 4.8

Soil depth, rooting depth, and available water capacity (A.W.C.) are slightly higher where this plant association occurs as a major landscape component.

This plant association occurs predominantly on the following soil families:

Fine-loamy, mixed Argic Pachic Cryoborolls
Loamy-skeletal, mixed Argic Pachic Cryoborolls
Loamy-skeletal, mixed Typic Cryoborolls

ASSOCIATED VEGETATION

Within the Bridger-East EUI survey area, the ARTRV2 /TRSP2 p.a. occurs in association mostly with subalpine fir forests, subalpine grasslands dominated by Idaho fescue, and other big sagebrush plant associations. The table below lists the PNV types that occur as major landscape components within the geographic extent of the ARTRV2 /TRSP2 p.a. and the area over which each PNV type is also a component.

Associated PNV	Acres in Association	Percent Co-occurrence
POTR5/THFE c.t.	5,770	35%
POTR5/SYOR2/BRCA5 c.t.	5,770	35%
POTR5/BRCA5 c.t.	5,770	35%
SABO2/M.G. c.t.	5,770	35%
ABLA/RIMO2 p.a.	4,440	27%
ABLA/ARCO9 p.a.	4,440	27%
ARTRS2/TRSP2 p.a.	3,950	23%
ARLU-VAED c.t.	3,950	23%
ARTRV2/ELTR7 p.a.	2,450	15%
SABO2/CARO6 c.t.	2,450	15%

SERAL STAGES

Seral stage is based on canopy cover of understory decreasers and increasers; it is not directly related to sagebrush cover. The following table (p.63) compares the seral stages of this association in terms of canopy cover, ground cover, and environmental features. Given the small sample sizes, environmental conditions appear similar across seral stages.

There is too little data to make reliable comparisons between seral stages. The limited data available suggests that the effects of disturbance on this plant association include slight decreases in grass cover and total canopy cover, and a slight increase in forb cover.

ARTRV2/TRSP2 p.a. Plant Community Composition (n=10)

Common Name	Code	Late Seral[1] n = 2 Const	Late Seral[1] n = 2 Cover	Mid Seral n = 4 Const	Mid Seral n = 4 Cover	Early Seral n = 4 Const	Early Seral n = 4 Cover	Ecological Role
Shrubs:								
Vasey big sagebrush	ARTRV2 **	100	28	100	31	100	28	Major climax increaser
Utah mountain snowberry	SYORU	50	Tr	25	1	75	2	Minor climax increaser
mountain silver sagebrush	ARCAV2	50	Tr	-	-	25	Tr	Transition to wetter sites
subalpine big sagebrush	ARTRS2	-	-	-	-	25	2	Transition to wetter p.a.
Perennial Grasses:								
Idaho fescue	FEID *	100	38	100	17	75	17	Major climax decreaser
slender wheatgrass	ELTR7 *	100	4	100	10	100	3	Major climax decreaser
nodding brome	BRAN	100	1	25	6	25	5	Minor climax decreaser
prairie Junegrass	KOMA	50	4	25	Tr	-	-	Minor climax decreaser
Cusick's bluegrass	POCU3	50	3	-	-	-	-	Minor climax decreaser
Columbia needlegrass	STNE3	50	1	75	3	75	4	Minor climax decreaser
spike trisetum	TRSP2 **	50	1	75	2	75	5	Minor climax decreaser
purple oniongrass	MESP **	50	1	50	2	50	1	Minor climax decreaser
timber oatgrass	DAIN	50	Tr	25	1	25	2	On wetter microsites
mountain brome	BRCA5	-	-	75	10	-	-	Minor climax decreaser
big bluegrass	POJUA	-	-	75	4	75	3	Minor climax decreaser
alkali bluegrass	POJU	-	-	50	2	25	1	Minor climax decreaser
fringed brome	BRCI2	-	-	-	-	50	3	Minor climax decreaser
bluegrass	POA	-	-	-	-	50	8	Minor climax decreaser
Sedges and Rushes:								
sedge	CAREX	100	4	75	1	100	4	Minor climax
Raynolds' sedge	CARA6	50	1	50	1	-	-	Minor climax decreaser
Ross' sedge	CARO5	-	-	-	-	25	6	Incidental
Perennial Forbs:								
sticky geranium	GEVI2 **	100	9	100	4	100	6	Minor climax
northwest cinquefoil	POGR9 *	100	5	100	4	100	5	Minor climax
sulphur buckwheat	ERUM	100	5	100	4	100	7	Increases on bared soil
green gentian	SWRA	100	4	25	3	50	Tr	Minor climax
western yarrow	ACMIL3	100	2	75	2	100	2	Minor climax increaser
pussytoes	ANTEN	100	2	50	6	100	3	Increases on bared soil
strawberry	FRAGA	100	2	-	-	50	5	Minor climax increaser
milkvetch	ASTRA	100	1	-	-	25	8	Minor climax increaser
rockcress	ARABI2	100	Tr	50	Tr	50	Tr	Minor climax
Indian paintbrush	CASTI2	100	Tr	50	Tr	25	Tr	Minor climax
groundsel	SENEC	50	5	50	2	50	1	Decreases w/ sheep use
aster	ASTER	50	5	75	13	-	-	Minor climax increaser
manyglands cinquefoil	POGLP2	50	3	-	-	50	6	Minor climax increaser
fernleaf licoriceroot	LIFI	50	2	25	3	-	-	Decreases w/ sheep use
ballhead sandwort	ARCO5	50	2	25	4	25	Tr	Increases on bared soil
meadowrue	THALI2	50	1	25	2	25	Tr	Minor climax
tall larkspur	DEOC	50	Tr	25	1	-	-	Minor climax
common dandelion	TAOF	50	Tr	100	1	50	1	Alien increaser
pale agoseris	AGGL	50	Tr	75	1	75	3	Minor climax
violet	VIOLA	-	-	75	Tr	25	Tr	Minor climax
prairiesmoke	GETR	-	-	50	8	50	1	Minor climax increaser
lupine	LUPIN	-	-	50	1	25	2	Minor Climax Increaser
orange sneezeweed	HEHO5	-	-	25	15	50	2	Minor Climax Increaser
fireweed	EPAN2	-	-	25	2	25	3	Increases on bared soil
fleabane	ERIGE2	-	-	25	2	50	3	Minor climax increaser
blue flax	LILE3	-	-	25	1	50	2	Minor climax decreaser
Annual Forbs:	AAFF	-	-	50	2	100	3	Increase on bared soil

** = Diagnostic species. * = Character species.

1. Seral stage is based on cover of understory decreasers and increasers; it is not directly related to sagebrush cover.

	Late n=2	Mid n=4	Early n=4
Canopy Cover:			
Shrubs	28	32	29
Graminoids	48	44	37
Forbs	33	41	39
Cover Sum	121	121	114
Ground Cover:			
Basal Vegetation	10	11	11
Litter & Wood	81	71	79
Moss & Lichen	1	0	1
Rock	3	6	5
Bare Soil	6	13	6
Environment:			
Slope (%)	7	18	18
Precipitation (in)	28	28	26
Elevation (ft)	8375	8859	8318
Aspect	S,E	W,S,N	S,W,E

MANAGEMENT IMPLICATIONS

Fire Response: Vasey big sagebrush plant associations have a natural fire frequency between 20 and 40 years (Winward 1991). Presettlement fires burned unevenly leaving islands and stringers of sagebrush unburned during any one fire. Fire intensity varied in the areas that did burn. The result of such fires was an ever changing mosaic of different densities and ages of sagebrush plants, ranging from recently burned, open grasslands to very dense sagebrush stands that had not burned in a long time (Winward 1991).

The seeds of Vasey big sagebrush are stimulated to germinate by the heat of a fire (Champlin and Winward 1982; Hironaka *et al*. 1983; Crane and Fischer 1986). After a burn it can recover to 20 percent canopy cover in as little as 12 years (Winward 1991). In the absence of fire Vasey big sagebrush continues to increase in density and cover, and may reach canopy cover values as high as 45 percent. If sagebrush canopy cover exceeds 20 percent for a long period of time, the density, cover, and biomass of herbaceous species will be reduced through shading and competition for moisture. Fire suppression over the last 80 years has allowed dense sagebrush canopies to develop over much of the area occupied by this plant association. A 20 to 40 year cycle of sagebrush removal or thinning is needed to maintain natural amounts of grasses and forbs in this plant association (Winward 1991).

Idaho fescue can be severely damaged by hot summer or fall fires. Grasses can increase in this plant association following removal of sagebrush by a cool fire. For best results, a burned area should be rested from grazing for two growing seasons. This may be difficult in areas of heavy wildlife use. Rest from grazing immediately after a burn allows grass plants to increase in vigor and produce seed while competition from sagebrush is lowest.

Big Game Habitat: This plant association provides summer foraging areas for elk, deer, and occasionally moose. Deer and elk use is greatest in areas where this association is intermixed with conifer stands.

Livestock Production: The abundance of forbs in this plant association make it better suited for sheep than cattle. Idaho fescue and slender wheatgrass are key forage species for both kinds of livestock. On sheep ranges sticky geranium, northwest cinquefoil, and other forbs are also important.

Response to Grazing: Grasses that decrease with overgrazing include Idaho fescue, slender wheatgrass, prairie junegrass, and Cusick's bluegrass. Forbs generally increase with cattle grazing, but many forb species decrease with sheep use. These include sticky geranium, fernleaf licoriceroot, northwest cinquefoil, groundsel, and pale agoseris. Forbs that increase with overgrazing include western yarrow, sulphur buckwheat, pussytoes, lupine, and prairiesmoke.

Heavy grazing of understory species can enhance the natural tendency of Vasey big sagebrush to increase in density and cover in two ways. First, by reducing competition from grasses and forbs. Second, by reducing fine fuels and thereby reducing the spread of wildfires. This increases the interval between fires and allows sagebrush cover to increase for a longer period of time.

Revegetation: The herbaceous layer of this plant association can be severely reduced by competition from overly dense sagebrush (see Fire Response) and/or improper grazing. Stands with moderately depleted understories may be capable of natural revegetation with appropriate management. To promote natural revegetation, management must allow the remaining desirable plants to increase in vigor and produce seed, and then allow seedlings to become established. This may require rest from grazing or deferment of grazing until after seed set. This may be difficult in areas used by wildlife.

If sagebrush cover is more than 20 percent, then some type of shrub removal will be needed to release the understory from competition (Winward 1991). Chemical or mechanical treatments may reduce sagebrush cover for a longer time period than prescribed burning because germinantion of Vasey big sagebrush seeds is stimulated by the heat of a fire.

Rodent burrowing is common in this plant association. High levels of activity can severely hamper revegetation.

Watershed: In late seral stands of this plant association the canopy cover sum ranges from 109 to 133 percent, with a mean of 121 percent. Bare soil ranges from 2 to 10 percent. So in relatively undisturbed stands, nearly all of the soil surface is protected from rain drop impact and most of the surface is protected from runoff. In early seral stands the cover sum ranges from 83 to 141 percent, with a mean of 114 percent. Bare soil ranges from 2 to 25 percent in mid and early seral stands. Improper grazing,

fire and rodent burrowing all reduce ground cover and expose more of the soil surface to rain drop impact and surface runoff. Stands with more than 20 percent bare soil are at risk of soil loss, which could lower site potential. This risk is greater on steeper slopes.

Much of the precipitation received by this plant association falls as snow and is subject to loss through sublimation and removal by wind. A shrub canopy helps minimize these losses. However, total water consumption is lower on sites where sagebrush is removed (Knight 1994). It is possible that dense sagebrush stands produced by fire suppression and overgrazing have reduced deep infiltration, ground water supplies, and stream flows from presettlement levels. The hydrologic effects of sagebrush
are more pronounced on deeper soils (Knight 1994).

COMPARISON TO OTHER STUDIES

Most classifications of sagebrush vegetation types have not taken big sagebrush taxonomy to the variety level, and big sagebrush taxonomy was refined after many of the classifications were done. These factors complicate the comparison of this plant association to other big sagebrush vegetation types.

This plant association is very similar to the *Geranium viscosissimum* phase of the *Artemisia tridentata* / *Festuca idahoensis* habitat type described in western Montana by Mueggler and Stewart (1980). It is also similar to the *Geranium viscosissimum* phase of the *Artemisia tridentata* ssp. *vaseyana* / *Festuca idahoensis* habitat type described by Tweit and Houston (1980) on the Shoshone National Forest.

E.U.I. CROSS REFERENCE

The ARTRV2/TRSP2 plant association forms all or part of the potential natural vegetation in the following ecological types from the Bridger-East EUI:

ARTRV2/TRSP2, Cambern Family ET
ARTRV2/ELTR7, Keman Family ET
ARTRV2/ELTR7, Decram Family ET

The above ecological types occur as major landscape components in the following map units:

3331 Sedimentary Moraines, Aspen - Big Sagebrush - Willow Complex

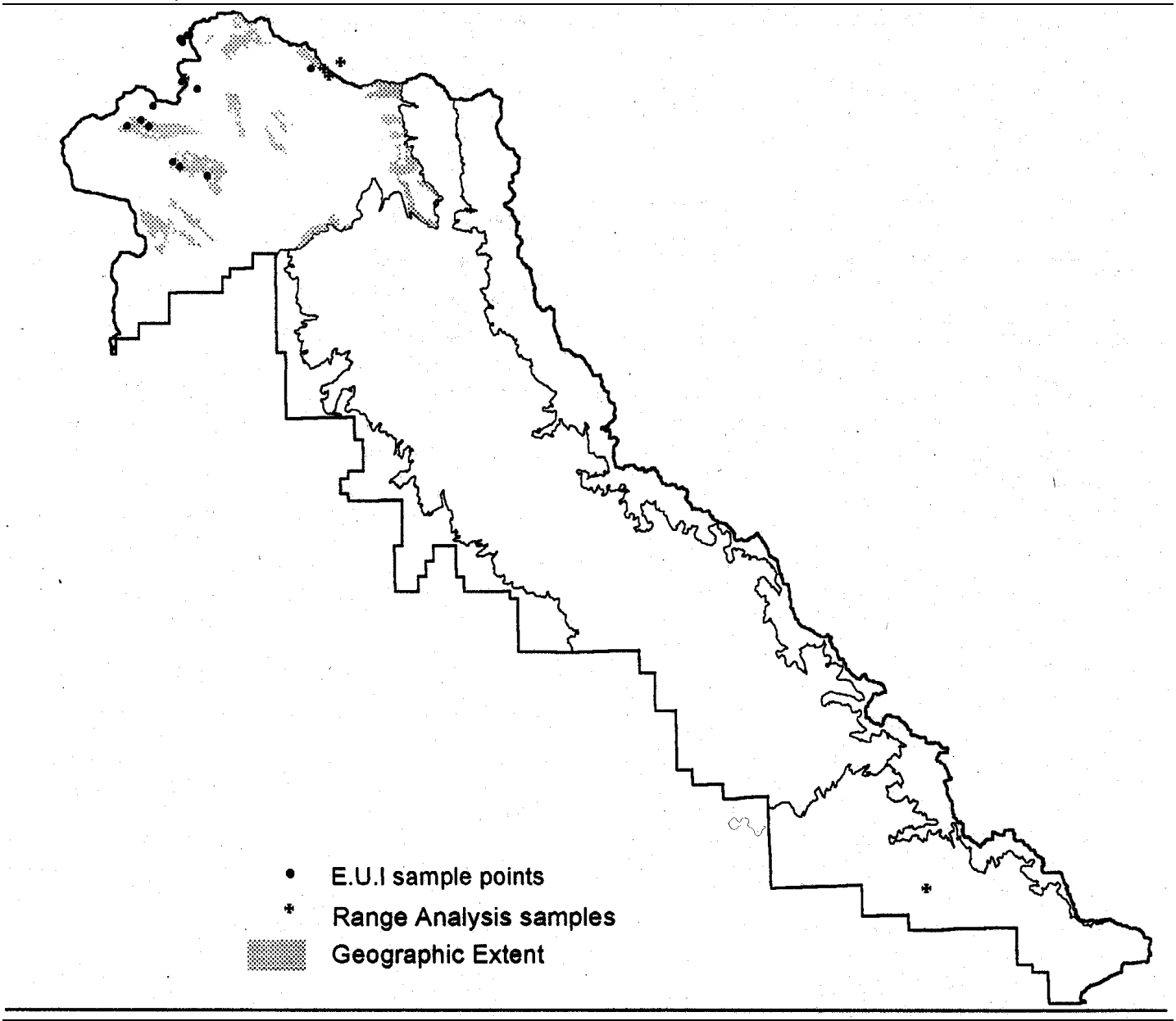
3346 Sedimentary Moraines,Subalpine fir - Big Sagebrush Complex

3521 Sedimentary Bottoms, Big Sagebrush - Willow Complex

3622 Sedimentary Sidslopes, Big Sagebrush - Tall Forb Complex

"The ordinary citizen today assumes that science knows what makes the community clock tick; the scientist is equally sure that he does not."
Aldo Leopold

Subalpine big sagebrush / slender wheatgrass Plant Association
Artemisia tridentata ssp. ***spiciformis / Elymus trachycaulus*** p.a.
ARTRS2/ELTR7 p.a.



DISTRIBUTION AND EXTENT

The ARTRS2/ELTR7 p.a. occurs as a major landscape component from Mosquito Lake east to Osborne Mountain and south to Twin Creek and Gypsum Creek in the Union Pass Uplands Subsection. It also occurs in minor amounts north of Block and Tackle Hill in the Southeastern Wind River Mountains Subsection. It has a geographic extent of about 18,800 acres and occupies about 5,100 acres within that area.

ENVIRONMENT

Landforms: Backslopes of non-glaciated mountains and ridges, and sideslopes and summits of glacial moraines and till-mantled mountain slopes.

Parent materials: Residuum and colluvium derived from sedimentary materials (mostly sandstone, limestone, and shale), or glacial till derived from mixed sedimentary and granitic materials.

n=21	Mean	Observed Range
Elevation (ft)	9314	9000 - 9720
Annual Precip. (in)	30	27 - 31
Slope (%)	15	3 - 45

Aspect: Mostly south, east and west.

Much of the precipitation received by this plant association falls as snow. Late melting snow packs limit the length of the growing season.

VEGETATION

Diagnostic Species: The ARTRS2/ELTR7 p.a. includes communities in which subalpine big sagebrush cover is at least 5 percent, and slender wheatgrass and northwest cinquefoil total at least 5 percent cover.

Shrubs: Subalpine big sagebrush is dominant and forms a medium shrub layer 2 to 3 feet tall. Vasey big sagebrush is sometimes present and indicates transition toward the slightly drier ARTRV2/ELTR7 p.a.

Herbs: Idaho fescue dominates the herb layer, and slender wheatgrass is often codominant. Columbia needlegrass, prairie junegrass, prairiesmoke, green gentian, and northwest cinquefoil are also common.

Production: Total annual production (current year's growth of shrubs and herbs) ranged from 1200 to 1900 lbs/acre on 4 range analysis transects in the Union Pass Uplands Subsection. One transect in the Southeastern Wind River Mountains had 600 lbs/acre, which may represent production on shallow soils. The range analysis transects were sampled in 1964 and 1966. They are on file at the Pinedale Ranger District.

Species Richness: The number of plant taxa per plot ($375m^2$) ranged from 10 to 36, with a mean of 27 across all seral stages. The only late seral plot has 36 taxa present. This plant association ranked fourth out of ten in species richness.

SOILS

This plant association occurs on well drained soils that range from very shallow to very deep to bedrock. Surface textures range from silt loams to gravelly sandy loams. The subsoil layer is predominantly loamy, loamy-skeletal, or fine-loamy. It has also been observed on soils with a coarse-loamy subsoil layer.

The table below lists the mean values for properties closely related to plant growth.

n = 12	Mean	Range
Depth to Restrictive Layer (in)	53+	7 - 93+
Rooting Depth (in)	21	7 - 44
A.W.C. to 40 inches (in)	3.8	1.7 - 6.5
A.W.C. to rooting depth (in)	2.6	1.7 - 4.9

The wide ranges in soil depth and available water capacity suggest that the distribution of this plant association is determined more by elevation and precipitation than by soil properties.

The following table lists soil attributes and the percentage of this plant association's areal extent over which those attributes occur.

Attribute	Percent of Areal Extent
Depth to Restrictive Layer	
Less than 40 inches	79%
40 inches or more	21%
Particle Size Class of Subsoil	
Loamy	68%
Loamy-skeletal	21%
Fine-loamy	11%
Drainage Class	
Well drained	100%
Clay Accumulation	
Argillic horizon present	15%
No argillic horizon	85%

This plant association occurs predominantly on the following soil families:

Loamy, mixed Lithic Cryoborolls
Loamy-skeletal, mixed Lithic Cryoborolls
Fine-loamy, mixed Argic Pachic Cryoborolls
Loamy-skeletal, mixed Typic Cryoborolls
Loamy-skeletal, mixed Mollic Cryoboralfs

ASSOCIATED VEGETATION

Within the Bridger-East EUI survey area, the ARTRS2 /ELTR7 p.a. occurs in association mostly with subalpine fir and quaking aspen forests, other big sagebrush plant associations, and riparian communities dominated by mountain silver sagebrush. The table below lists the PNV types that occur as major landscape components within the geographic extent of the ARTRS2 /ELTR7 p.a. and the area over which each PNV type is also a component.

Associated PNV	Acres in Association	Percent Co-occurrence
ABLA/CARO5 p.a.	9,460	50%
POTR5/THFE c.t.	9,460	50%
ARTRS2/TRSP2 p.a.	5,440	29%
ARTRV2/ELTR7 p.a.	3,860	21%
ARCAV2/DECE c.t.	3,860	21%
Grassland (FEID Series)	3,640	18%
ARCAV2/FEID c.t.	1,980	11%

SERAL STAGES

Seral stage is based on canopy cover of understory decreasers and increasers; it is not directly related to sagebrush cover. The following table (p.68) compares the seral stages of this association in terms of canopy cover, ground cover, and environmental features. The one late seral stand appears to be on a slightly cooler and moister site than the other stages, even though it is located on a moraine summit. The above table indicates that the major effects of disturbance on this plant association include decreases in grass cover and total canopy cover, and an

ARTRS2/ELTR7 p.a. Plant Community Composition (n=11)

Common Name	Code	Late Seral[1] n = 1 Const	Late Seral[1] n = 1 Cover	Mid Seral n = 5 Const	Mid Seral n = 5 Cover	Early Seral n = 5 Const	Early Seral n = 5 Cover	Ecological Role
Shrubs:								
subalpine big sagebrush	ARTRS2 **	100	37	100	24	100	30	Major climax increaser
shrubby cinquefoil	POFR4	100	8	-	-	20	2	On wetter microsites
Vasey big sagebrush	ARTRV2	-	-	20	10	-	-	Transition to drier p.a.
Perennial Grasses:								
Idaho fescue	FEID *	100	40	100	29	100	18	Major climax decreaser
slender wheatgrass	ELTR7 **	100	10	100	3	80	3	Major climax decreaser
Kentucky bluegrass	POPR	100	2	20	1	20	Tr	On wetter microsites
timber oatgrass	DAIN	100	1	40	2	60	1	On wetter microsites
prairie Junegrass	KOMA	100	1	40	2	60	1	Minor climax decreaser
Columbia needlegrass	STNE3	100	1	60	1	60	3	Minor climax decreaser
nodding brome	BRAN	100	Tr	40	1	-	-	Minor climax decreaser
alkali bluegrass	POJU	100	Tr	20	3	-	-	Minor climax decreaser
big bluegrass	POJUA	-	-	60	1	40	3	Minor climax decreaser
Letterman's needlegrass	STLE4	-	-	60	1	40	1	Minor climax increaser
Cusick's bluegrass	POCU3	-	-	40	4	-	-	Minor climax decreaser
spike trisetum	TRSP2	-	-	40	1	20	Tr	Transition to wetter p.a.
Canby's bluegrass	POSEE	-	-	20	4	80	2	Minor climax decreaser
fringed brome	BRCI2	-	-	20	Tr	40	2	Minor climax decreaser
oniongrass	MEBU	-	-	-	-	20	6	Minor climax decreaser
Sedges and Rushes:								
obtuse sedge	CAOB4	100	Tr	60	3	20	Tr	Minor climax increaser
dryland sedge	CAXE	-	-	40	1	40	2	Minor climax increaser
dunhead sedge	CAPH2	-	-	20	10	-	-	Incidental
Raynolds' sedge	CARA6	-	-	20	Tr	40	1	Transition to moister p.a.
Perennial Forbs:								
prairiesmoke	GETR	100	2	80	1	80	3	Minor climax increaser
green gentian	SWRA	100	2	80	Tr	80	1	Minor climax
strawberry	FRAGA	100	2	20	1	80	1	Minor climax increaser
northwest cinquefoil	POGR9 **	100	1	80	3	80	1	Minor climax
lupine	LUPIN	100	1	80	2	80	1	Minor climax increaser
fleabane	ERIGE2	100	1	80	Tr	60	1	Minor climax increaser
ballhead sandwort	ARCO5	100	1	40	2	40	7	Increases on bared soil
fireweed	EPAN3	100	1	20	Tr	40	Tr	Increases on bared soil
western yarrow	ACMIL3	100	Tr	100	2	80	2	Minor climax increaser
sulphur buckwheat	ERUM	100	Tr	100	3	100	4	Increases on bared soil
pussytoes	ANTEN	100	Tr	80	4	80	4	Increases on bared soil
rockcress	ARABI2	100	Tr	80	1	60	Tr	Minor climax
orange sneezeweed	HEHO5	100	Tr	60	3	20	2	Minor climax increaser
blue flax	LILE3	100	Tr	40	1	20	Tr	Minor climax decreaser
flowery phlox	PHMU3	100	Tr	20	1	20	Tr	Increases on bared soil
Hood's phlox	PHHO	100	Tr	-	-	60	1	Increases on bared soil
elk thistle	CISC2	100	Tr	-	-	20	Tr	Minor climax increaser
sticky geranium	GEVI2	-	-	60	2	40	1	Transition to wetter p.a.
common dandelion	TAOF	-	-	60	1	60	Tr	Alien increaser
pale agoseris	AGGL	-	-	40	2	20	Tr	Minor climax decreaser
groundsel	SENEC	-	-	40	Tr	80	2	Minor climax
Annual Forbs:								
rockjasmine	ANDRO3	100	Tr	80	Tr	80	Tr	Increases on bared soil
willowweed	EPILO	-	-	-	-	20	3	Increases on bared soil

** = Diagnostic species. * = Character species.

1. Seral stage is based on cover of understory decreasers and increasers; it is not directly related to sagebrush cover.

	Late n=1	Mid n=5	Early n=5
Canopy Cover:			
Shrubs	45	26	30
Graminoids	50	43	29
Forbs	10	18	23
Cover Sum	118	92	84
Ground Cover:			
Basal Vegetation	12	9	9
Litter & Wood	86	66	75
Moss & Lichen	1	1	0
Rock	0	14	7
Bare Soil	1	11	9
Environment:			
Slope (%)	6	13	15
Precipitation (in)	29	30	29
Elevation (ft)	9200	9422	9198
Aspect	N	S,E,W	E,W,S

increase in forb cover. These changes are evident between mid and early seral stands, not just late and mid seral.

MANAGEMENT IMPLICATIONS

Fire Response: Subalpine big sagebrush plant associations have a natural fire frequency between 20 and 40 years. Presettlement fires burned unevenly leaving islands and stringers of sagebrush unburned during any one fire. Fire intensity varied in the areas that did burn. The result of such fires was an ever changing mosaic of different densities and ages of sagebrush plants, ranging from recently burned, open grasslands to very dense sagebrush stands that had not burned in a long time (Winward 1991).

Subalpine big sagebrush can resprout after fire (Goodrich *et al*. 1985), so it can recover rapidly following a burn. The percentage of plants resprouting varies with fire intensity. In the absence of fire subalpine big sagebrush continues to increase in density and cover, and may reach canopy cover values as high as 45 percent. If sagebrush canopy cover exceeds 20 percent for a long period of time, the density, cover, and biomass of herbaceous species will be reduced through shading and competition for moisture. Fire suppression over the last 80 years has allowed dense sagebrush canopies to develop over much of the area occupied by this plant association. A 20 to 40 year cycle of sagebrush removal or thinning is needed to maintain natural amounts of grasses and forbs in this plant association.

Idaho fescue can be severely damaged by hot summer or fall fires. Grasses can increase in this plant association following removal of sagebrush by a cool fire. For best results, a burned area should be rested from grazing for two growing seasons. This may be difficult in areas of heavy wildlife use. Rest from grazing immediately after a burn allows grass plants to increase in vigor and produce seed while competition from sagebrush is lowest.

Big Game Habitat: This plant association provides summer foraging areas for elk, and occasionally deer, moose, and pronghorn antelope. Antelope have been observed only where this association occurs in large open areas in complex with grasslands.

Livestock Production: Idaho fescue and slender wheatgrass are the principle forage species in this plant association. Both are highly preferred by cattle and moderately preferred by sheep. Livestock use is limited by steep slopes in some areas.

Response to Grazing: Grasses that decrease with overgrazing include Idaho fescue, slender wheatgrass, Columbia needlgrass, and Cusick's bluegrass. Forbs generally increase with cattle grazing, but many forb species decrease with sheep use. These include northwest cinquefoil, sticky geranium, groundsel, and pale agoseris. Forbs that increase with overgrazing include prairiesmoke, western yarrow, sulphur buckwheat, pussytoes, lupine, and ballhead sandwort.

Heavy grazing of understory species can enhance the natural tendency of subalpine big sagebrush to increase in density and cover in two ways. First, by reducing competition from grasses and forbs. Second, by reducing fine fuels and thereby reducing the spread of wildfires. This increases the interval between fires and allows sagebrush cover to increase for a longer period of time.

Revegetation: The herbaceous layer of this plant association can be severely reduced by competition from overly dense sagebrush (see Fire Response), improper grazing and/or rodent burrowing. Stands with moderately depleted understories may be capable of natural revegetation with appropriate management. To promote natural revegetation, management must allow the remaining desirable plants to increase in vigor and produce seed, and then allow seedlings to become established. This may require rest from grazing or deferment of grazing until after seed set.

If sagebrush cover is more than 20 percent, then some type of shrub removal will be needed to release the understory from competition (Winward 1991). Chemical treatments may reduce sagebrush cover for a longer time period than prescribed burning or mechanical treatments. Systemic herbicides should be more effective than defoliants because of the resprouting ability of subalpine big sagebrush.

Rodent burrowing is somwhat common in this plant association. High levels of rodent activity can severely hamper revegetation.

Watershed: In the only late seral stand of this plant association the canopy cover sum is 118 percent. Bare soil is 1 percent. So in relatively undisturbed stands, nearly all of the soil surface is protected from rain drop impact and most of the surface is protected from runoff. In early seral stands the cover sum ranges from 74 to 97 percent, with a mean of 84 percent. Bare soil ranges from 3 to 15 percent. Improper grazing, fire and rodent

burrowing all reduce ground cover and expose more of the soil surface to rain drop impact and surface runoff. Stands with more than 20 percent bare soil are at risk of soil loss, which could lower site potential. This risk is greater on steeper slopes.

Much of the precipitation received by this plant association falls as snow and is subject to loss through sublimation and removal by wind. A shrub canopy helps minimize these losses. However, total water consumption is lower on sites where sagebrush is removed (Knight 1994). It is possible that dense sagebrush stands produced by fire suppression and overgrazing have reduced deep infiltration, ground water supplies, and stream flows from presettlement levels. The hydrologic effects of sagebrush are more pronounced on deeper soils (Knight 1994).

COMPARISON TO OTHER STUDIES

Most classifications of sagebrush vegetation types have not taken big sagebrush taxonomy to the variety level, and big sagebrush taxonomy was refined after many of the classifications were done. One of those refinements was distinguishing subspecies *spiciformis* from subspecies *vaseyana* (Goodrich *et al*. 1985). This complicates the comparison of this plant association to other big sagebrush vegetation types.

The understory of this plant association is somewhat similar to the *Geranium viscosissimum* phase of the *Artemisia tridentata* / *Festuca idahoensis* habitat type described in western Montana by Mueggler and Stewart (1980). Since that habitat type occurs in areas with up to 30 inches of annual precipitation, it may include some stands dominated by subalpine big sagebrush. This may also be true of the *Artemisia tridentata* ssp. *vaseyana* / *Festuca idahoensis* habitat type described by Tweit and Houston (1980) on the Shoshone National Forest.

This plant association is similar to some stands of the *Artemisia rothrockii -Artemisia tridentata* ssp. *vaseyana* form. *spiciformis* / Mountain Forb h.t. described by Bramble-Brodahl (1978) along the Gros Ventre River. The taxon she referred to as "*Artemisia rothrockii*" is now considered to be *Artemisia tridentata* ssp. *spiciformis* (Shultz 1984; Goodrich *et al*. 1985). "*Artemisia tridentata* ssp. *vaseyana* form. *spiciformis*" is equivalent to *A. t*. ssp. *vaseyana* var. *vaseyana* (Goodrich *et al*. 1985).

E.U.I. CROSS REFERENCE

The ARTRS2/ELTR7 plant association forms part of the potential natural vegetation in the following ecological types from the Bridger-East EUI:

ARTRS2, Lithic Cryoborolls ET
ARTRS2, Cambern Family ET
ARTRV2-ARTRS2, Guiser Family ET
ARTRV2-ARTRS2, Decram Family ET

The above ecological types occur as major landscape components in the following map units:

3322 Sedimentary Till Plains, Big Sagebrush - Silver Sagebrush Complex

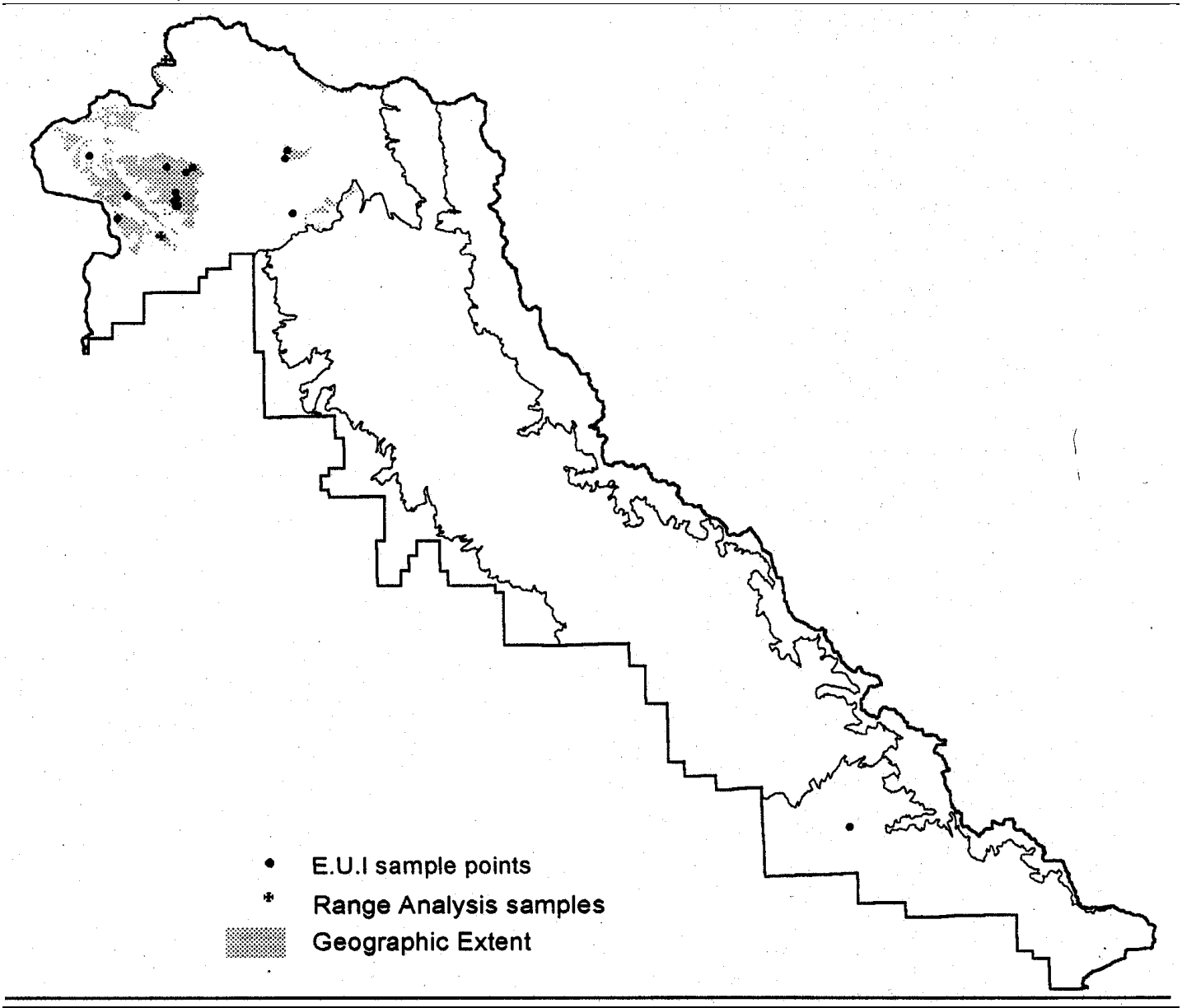
3621 Sedimentary Sideslopes, Big Sagebrush - Silver Sagebrush Complex

3624 Sedimentary Residual Sideslopes, Big Sagebrush - Grassland Comlpex

3649 Sedimentary Sideslopes, Subalpine fir - Big Sagebrush - Aspen Complex

Pessimists are surprised just as often as optimists, only pleasantly.

Subalpine big sagebrush / spike trisetum Plant Association
Artemisia tridentata ssp. ***spiciformis / Trisetum spicatum*** p.a.
ARTRS2/TRSP2 p.a.



DISTRIBUTION AND EXTENT

The ARTRS2/TRSP2 p.a. occurs as a major landscape component from the Gros Ventre Wilderness south to Twin Creek and east to Little Sheep Mountain in the Union Pass Uplands Subsection. It also occurs in minor amounts near Big Sandy Opening in the Southeastern Wind River Mountains Subsection. It has a geographic extent of about 19,900 acres and occupies about 4,700 acres within that area.

ENVIRONMENT

This is the coolest and wettest big sagebrush plant association on the Pinedale Ranger District.

Landforms: Backslopes of non-glaciated mountains and ridges, and sideslopes and summits of glacial moraines and till-mantled mountain slopes.

Parent materials: Residuum and colluvium derived from sedimentary materials (mostly sandstone, limestone, and shale), or glacial till derived from mixed sedimentary and granitic materials.

n=17	Mean	Observed Range
Elevation (ft)	9247	8760 - 9820
Annual Precip. (in)	29	26 - 32
Slope (%)	17	4 - 50

Aspect: Mostly east and south.

Much of the precipitation received by this plant association falls as snow. Late melting snow packs limit the length of the growing season.

VEGETATION

Diagnostic Species: The ARTRS2/TRSP2 p.a. includes communities in which subalpine big sagebrush cover is at least 5 percent, and spike trisetum, sticky geranium, purple oniongrass, and/or Raynold's sedge total at least 5 percent cover.

Shrubs: Subalpine big sagebrush is dominant and forms a medium shrub layer 2 to 3 feet tall. Vasey big sagebrush is sometimes present and indicates transition toward the slightly drier ARTRV2/TRSP2 p.a.

Herbs: Idaho fescue dominates the herb layer, and slender wheatgrass is often codominant. Columbia needlegrass, Cusick's bluegrass, western yarrow, and northwest cinquefoil are also common, in addition to the diagnostic species listed above.

Production: Total annual production (current year's growth of shrubs and herbs) ranged from 1400 to 2100 lbs/acre on 2 range analysis transects. This very limited data suggests that this plant association is similar, or slightly lower, in productivity to the ARTRV2/TRSP2 plant association. These transects were sampled in 1964 and 1975. They are on file at the Pinedale Ranger District.

Species Richness: The number of plant taxa per plot ($375m^2$) ranged from 17 to 33, with a mean of 24 across all seral stages. Late seral plots averaged 25 taxa present. This plant association ranked seventh out of ten in species richness.

SOILS

This plant association occurs on well drained soils that range from very shallow to very deep to bedrock. Surface textures are mostly loams, sandy loams, and gravelly sandy loams. The subsoil layer is predominantly loamy-skeletal or coarse-loamy. It has also been observed on soils with a fine-loamy subsoil layer.

The table below lists the mean values for properties closely related to plant growth.

n = 13	Mean	Range
Depth to Restrictive Layer (in)	35+	5 - 60+
Rooting Depth (in)	28	5 - 43
A.W.C. to 40 inches (in)	3.1	0.4 - 5.4
A.W.C. to rooting depth (in)	2.7	0.4 - 5.7

The wide ranges in soil depth and available water capacity suggest that the distribution of this plant association is determined more by elevation and precipitation than by soil properties.

The following table lists soil attributes and the percentage of this plant association's areal extent over which those attributes occur.

Attribute	Percent of Areal Extent
Depth to Restrictive Layer	
Less than 40 inches	56%
40 inches or more	44%
Particle Size Class of Subsoil	
Loamy-skeletal	55%
Coarse-loamy	45%
Drainage Class	
Well drained	100%
Clay Accumulation	
No argillic horizon present	100%

This plant association occurs predominantly on the following soil families:

Coarse-loamy, mixed Pachic Cryoborolls
Loamy-skeletal, mixed Typic Cryoborolls
Loamy-skeletal, mixed Lithic Cryoborolls
Loamy-skeletal, mixed Typic Cryochrepts

It has also been observed on Fine-loamy, mixed Argic Pachic Cryoborolls and Loamy-skeletal, mixed Argic Cryoborolls.

ASSOCIATED VEGETATION

Within the Bridger-East EUI survey area, the ARTRS2 /TRSP2 p.a. occurs in association mostly with subalpine fir forests, subalpine grasslands, and other big sagebrush plant associations. The table below lists the PNV types that occur as major landscape components within the geographic extent of the ARTRS2 /TRSP2 p.a. and the area over which each PNV type is also a component.

Associated PNV	Acres in Association	Percent Co-occurrence
ABLA/VASC p.a.	7,020	36%
ABLA/CARO5 p.a.	7,020	36%
Grassland (FEID Series)	6,790	35%
ARTRV2/TRSP2 p.a.	3,950	20%
ARLU-VAED c.t.	3,950	20%
ARTRS2/ELTR7 p.a.	3,950	17%
ARTRV2/ELTR7 p.a.	1,980	10%
ARCAV2/FEID c.t.	1,980	10%

SERAL STAGES

Seral stage is based on canopy cover of understory decreasers and increasers; it is not directly related to sagebrush cover. The following table (p.73) compares the seral stages of this association in terms of canopy cover, ground cover, and environmental features. Environmental conditions are similar across seral stages except for aspect. Early seral stands occur on south aspects more often than late seral stands. This suggests that some of the differences between seral stages may be due in part to differences in temperature and moisture.

ARTRS2/TRSP2 p.a. Plant Community Composition (n=15)

Common Name	Code	Late Seral[1] n = 5 Const	Late Seral[1] n = 5 Cover	Mid Seral n = 6 Const	Mid Seral n = 6 Cover	Early Seral n = 4 Const	Early Seral n = 4 Cover	Ecological Role
Shrubs:								
subalpine big sagebrush	ARTRS2 **	100	22	100	26	100	26	Major climax increaser
Vasey big sagebrush	ARTRV2	40	8	-	-	-	-	Transitional to drier sites
mountain silver sagerbush	ARCAV2	40	1	-	-	-	-	On wetter microsites
Utah mountain snowberry	SYORU	-	-	17	3	-	-	Incidental
Perennial Grasses:								
Idaho fescue	FEID *	100	29	100	23	100	14	Major climax decreaser
slender wheatgrass	ELTR7 *	100	15	100	6	100	5	Major climax decreaser
Columbia needlegrass	STNE3	80	6	83	2	100	1	Minor climax decreaser
Cusick's bluegrass	POCU3	80	3	50	1	100	3	Minor climax decreaser
spike trisetum	TRSP2 **	80	3	67	5	75	3	Minor climax decreaser
big bluegrass	POJUA	60	6	17	Tr	25	3	Minor climax decreaser
purple oniongrass	MESP **	60	2	17	1	50	1	Minor climax decreaser
timber oatgrass	DAIN	40	3	-	-	25	Tr	On wetter microsites
Canby's bluegrass	POSEE	20	3	50	2	-	-	Minor climax decreaser
Sedges and Rushes:								
Raynolds' sedge	CARA6 **	60	2	83	4	25	2	Minor climax decreaser
sedge	CAREX	60	Tr	33	1	50	9	Minor climax increaser
Perennial Forbs:								
western yarrow	ACMIL3	100	3	83	1	100	1	Minor climax increaser
northwest cinquefoil	POGR9 *	100	1	100	4	100	1	Minor climax
sticky geranium	GEVI2 **	80	8	83	3	100	2	Minor climax
groundsel	SENEC	80	3	50	1	25	Tr	Decreases w/ sheep use
rockcress	ARABI2	80	Tr	50	Tr	75	Tr	Minor climax
sulphur buckwheat	ERUM	60	4	83	7	100	3	Increases on bared soil
pussytoes	ANTEN	60	3	67	1	75	3	Increases on bared soil
aster	ASTER	60	3	67	4	50	6	Minor climax increaser
phlox	PHLOX	60	2	67	1	50	4	Minor climax
ballhead sandwort	ARCO5	60	1	17	Tr	50	1	Increases on bared soil
green gentian	SWRA	60	1	67	2	25	5	Minor climax
fernleaf licoriceroot	LIFI	40	10	67	4	75	3	Decreases w/ sheep use
pale agoseris	AGGL	40	3	33	1	-	-	Minor climax decreaser
Indian paintbrush	CASTI2	40	2	50	1	50	1	Minor climax
lupine	LUPIN	40	2	67	5	50	8	Minor climax increaser
meadowrue	THALI2	40	1	50	3	-	-	Minor climax
orange sneezeweed	HEHO5	40	1	17	1	25	Tr	Minor climax increaser
prairiesmoke	GETR	40	1	17	5	50	3	Minor climax increaser
common dandelion	TAOF	40	1	33	1	-	-	Alien increaser
tall larkspur	DEOC	40	Tr	33	2	-	-	Minor climax increaser
helianthella	HELIA	20	8	17	20	-	-	Incidental
Annual Forbs:								
Douglas' knotweed	PODO4	60	1	33	1	25	4	Increases on bared soil
pygmyflower rockjasmine	ANSES	40	Tr	50	Tr	-	-	Increases on bared soil
narrowleaf mountaintrumpet	COLI2	20	1	17	5	25	2	Increases on bared soil

** = Diagnostic species. * = Character species.

1. Seral stage is based on cover of understory decreasers and increasers; it is not directly related to sagebrush cover.

	Late n=5	Mid n=6	Early n=4
Canopy Cover:			
Shrubs	25	26	26
Graminoids	57	39	32
Forbs	30	35	25
Cover Sum	120	103	86
Ground Cover:			
Basal Vegetation	10	10	8
Litter & Wood	80	77	77
Moss & Lichen	0	0	0
Rock	2	4	7
Bare Soil	7	9	8
Environment:			
Slope (%)	9	18	17
Precipitation (in)	28	29	30
Elevation (ft)	9200	9218	9288
Aspect	E,N	S,E,N,W	S,E

The above table indicates that the major effects of disturbance on this plant association include decreases in grass cover and total canopy cover. There is little difference in ground cover between seral stages.

MANAGEMENT IMPLICATIONS

Fire Response: Subalpine big sagebrush plant associations have a natural fire frequency between 20 and 40 years. Presettlement fires burned unevenly leaving islands and stringers of sagebrush unburned during any one fire. Fire intensity varied in the areas that did burn. The result of such fires was an ever changing mosaic of different densities and ages of sagebrush plants, ranging from recently burned, open grasslands to very dense sagebrush stands that had not burned in a long time (Winward 1991).

Subalpine big sagebrush can resprout after fire (Goodrich *et al*. 1985), so it can recover rapidly following a burn. The percentage of plants resprouting varies with fire intensity. In the absence of fire subalpine big sagebrush continues to increase in density and cover, and may reach canopy cover values as high as 45 percent. If sagebrush canopy cover exceeds 20 percent for a long period of time, the density, cover, and biomass of herbaceous species will be reduced through shading and competition for moisture. Fire suppression over the last 80 years has allowed dense sagebrush canopies to develop over much of the area occupied by this plant association. A 20 to 40 year cycle of sagebrush removal or thinning is needed to maintain natural amounts of grasses and forbs in this plant association.

Idaho fescue can be severely damaged by hot summer or fall fires. Grasses can increase in this plant association following removal of sagebrush by a cool fire. For best results, a burned area should be rested from grazing for two growing seasons. This may be difficult in areas of heavy wildlife use. Rest from grazing immediately after a burn allows grass plants to increase in vigor and produce seed while competition from sagebrush is lowest.

Big Game Habitat: This plant association provides summer foraging areas for elk, deer, and occasionally pronghorn antelope. Deer and elk use is greatest in areas where this association is intermixed with conifer stands. Antelope have been observed only where this association occurs in large open areas in complex with grasslands.

Livestock Production: The abundance of forbs in this plant association make it better suited for sheep than cattle. Idaho fescue and slender wheatgrass are key forage species for both kinds of livestock. On sheep ranges sticky geranium, northwest cinquefoil, fernleaf licoriceroot, and other forbs are also important.

Response to Grazing: Grasses that decrease with overgrazing include Idaho fescue, slender wheatgrass, Columbia needlgrass, and Cusick's bluegrass. Forbs generally increase with cattle grazing, but many forb species decrease with sheep use. These include sticky geranium, fernleaf licoriceroot, northwest cinquefoil, groundsel, and pale agoseris. Forbs that increase with overgrazing include western yarrow, sulphur buckwheat, pussytoes, lupine, and prairiesmoke.

Heavy grazing of understory species can enhance the natural tendency of subalpine big sagebrush to increase in density and cover in two ways. First, by reducing competition from grasses and forbs. Second, by reducing fine fuels and thereby reducing the spread of wildfires. This increases the interval between fires and allows sagebrush cover to increase for a longer period of time.

Revegetation: The herbaceous layer of this plant association can be severely reduced by competition from overly dense sagebrush (see Fire Response), improper grazing and/or rodent burrowing. Stands with moderately depleted understories may be capable of natural revegetation with appropriate management. To promote natural revegetation, management must allow the remaining desirable plants to increase in vigor and produce seed, and then allow seedlings to become established. This may require rest from grazing or deferment of grazing until after seed set.

If sagebrush cover is more than 20 percent, then some type of shrub removal will be needed to release the understory from competition (Winward 1991). Chemical treatments may reduce sagebrush cover for a longer time period than prescribed burning or mechanical treatments. Systemic herbicides should be more effective than defoliants because of the resprouting ability of subalpine big sagebrush.

Rodent burrowing is very common in this plant association. High levels of activity can severely hamper revegetation.

Watershed: In late seral stands of this plant association the canopy cover sum ranges from 99 to 158 percent, with a mean of 120 percent. Bare soil ranges from 5 to 10 percent. So in relatively undisturbed stands, nearly all

of the soil surface is protected from rain drop impact and most of the surface is protected from runoff. In early seral stands the cover sum ranges from 45 to 127 percent, with a mean of 86 percent. Bare soil ranges from 7 to 30 percent. Improper grazing, fire and rodent burrowing all reduce ground cover and expose more of the soil surface to rain drop impact and surface runoff. Stands with more than 20 percent bare soil are at risk of soil loss, which could lower site potential. This risk is greater on steeper slopes.

Much of the precipitation received by this plant association falls as snow and is subject to loss through sublimation and removal by wind. A shrub canopy helps minimize these losses. However, total water consumption is lower on sites where sagebrush is removed (Knight 1994). It is possible that dense sagebrush stands produced by fire suppression and overgrazing have reduced deep infiltration, ground water supplies, and stream flows from presettlement levels. The hydrologic effects of sagebrush are more pronounced on deeper soils (Knight 1994).

COMPARISON TO OTHER STUDIES

Most classifications of sagebrush vegetation types have not taken big sagebrush taxonomy to the variety level, and big sagebrush taxonomy was refined after many of the classifications were done. One of those refinements was distinguishing subspecies *spiciformis* from subspecies *vaseyana* (Goodrich *et al*. 1985). This complicates the comparison of this plant association to other big sagebrush vegetation types.

The understory of this plant association is very similar to the *Geranium viscosissimum* phase of the *Artemisia tridentata* / *Festuca idahoensis* habitat type described in western Montana by Mueggler and Stewart (1980). Since that habitat type occurs in areas with up to 30 inches of annual precipitation, it may include some stands dominated by subalpine big sagebrush. This may also be true of the *Artemisia tridentata* ssp. *vaseyana* / *Festuca idahoensis* habitat type described by Tweit and Houston (1980) on the Shoshone National Forest.

This plant association is similar to some stands of the *Artemisia rothrockii -Artemisia tridentata* ssp. *vaseyana* form. *spiciformis* / Mountain Forb h.t. described by Bramble-Brodahl (1978) along the Gros Ventre River. The taxon she referred to as "*Artemisia rothrockii*" is now considered to be *Artemisia tridentata* ssp. *spiciformis* (Shultz 1984; Goodrich *et al*. 1985). "*Artemisia tridentata* ssp. *vaseyana* form. *spiciformis*" is equivalent to *A. t*. ssp. *vaseyana* var. *vaseyana* (Goodrich *et al*. 1985).

E.U.I. CROSS REFERENCE

The ARTRS2/TRSP2 plant association forms all or part of the potential natural vegetation in the following ecological types from the Bridger-East EUI:

ARTRS2, Lithic Cryoborolls ET
ARTRS2/TRSP2, Frindle Family ET
ARTRS2/TRSP2, Naz Family ET
ARTRV2-ARTRS2, Decram Family ET

The above ecological types occur as major landscape components in the following map units:

3621 Sedimentary Sideslopes, Big Sagebrush - Silver Sagebrush Complex

3622 Sedimentary Sideslopes, Big Sagebrush - Tall Forb Complex

3624 Sedimentary Residual Sideslopes, Big Sagebrush -Grassland Comlpex

3645 Sedimentary Sideslopes, Subalpine fir – Big Sagebrush Complex

3652 Sedimentary Colluvial Sideslopes, Big Sagebrush - Grassland Complex

No matter how many steps you take, if the direction of each step is chosen randomly you will tend to end up where you started.

LITERATURE CITED

Beetle, Alan A. and Kendall L. Johnson. 1982. Sagebrush in Wyoming. University of Wyoming Agricultural Experiment Station, Bulletin 779, Laramie, WY. 68p.

Bradley, Anne F., Nonan V. Noste, and William C. Fischer. 1992. Fire Ecology of Forests and Woodlands in Utah. USDA Forest Service, Intermountain Research Station, General Technical Report INT-287. Ogden, UT. 128p.

Bramble-Brodahl, Mary Kay. 1978. Classification of Artemisia Vegetation in the Gros Ventre Area, Wyoming. M.S. Thesis, University of Idaho. Moscow, ID. 126 p.

Champlin, M. R. and A. H. Winward. 1982. The effect of simulated fire on emergence of seeds found in the soil of big sagebrush communities. Abstract of Papers. Society for Range Management. Calgary, Alberta. p.37.

Crane, M. F. and William C. Fischer. 1986. Fire Ecology of the Forest Habitat Types of Central Idaho. USDA Forest Service, Intermountain Research Station, General Technical Report INT-218, Ogden, UT. 86p.

Daubenmire, R. 1970. Steppe Vegetation of Washingtion. Washington Agricultural Experiment Station Technical Bulletin 62. Washington State University. Pullman, WA. 131 p.

Dorn, Robert D. 1992. Vascular Plants of Wyoming. 2nd edition. Mountain West Publishing, Cheyene, WY. 340 p.

Driver, C. H. 1983. Potentials for the management of bitterbrush habitats by the use of prescribed fire. USDA Forest Service General Technical Report INT-152, Intermountain Research Station, Ogden, UT.

Driver, C.H. 1990. Effects of fire in bitterbrush types. pp. 84-85. *In* Fire in Pacific Northwest Ecosystems. Thomas E. Bedell, editor.. Department of Rangeland Resources, Oregon State University, Covallis, OR. 145p.

Gauch, Hugh G. Jr. 1982. Multivariate Analysis in Community Ecology. Cambridge University Press. New York, NY. 298 p.

Goodrich, Sherel, E. Durant MacAurthur, and Alma H. Winward. 1985. A new combination and a new variety in *Artemisia tridentata*. Great Basin Naturalist 45: 99-104.

Hill, M. O. 1979. DECORANA: A FORTRAN Program for Detrended Correspondence Analysis and Reciprocal Averaging. Cornell University. Ithaca, NY.

Hironaka, M., M. A. Fosberg, and A. H. Winward. 1983. Sagebrush-Grass Habitat Types of Southern Idaho. University of Idaho Forest, Wildlife and Range Experiment Station, Bulletin Number 35, Moscow, ID. 44p.

Johnson, Daniel M. and John O. Dart. 1982. Variability of Precipitation in the Pacific Northwest: Spatial and Temporal Characteristics. Water Resources Research Institute Report WRRI-77. Oregon State University. Corvallis, OR. 328p.

Kauffman, J. Boone. 1990. The Ecology of Fire in Rangelands: Historical and Current Contexts. pp. 2-5. *In* Fire in Pacific Northwest Ecosystems. Thomas E. Bedell, editor.. Department of Rangeland Resources, Oregon State University, Covallis, OR. 145p.

Knight, Dennis H. 1994. Mountains and Plains: The Ecology of Wyoming Landscapes. Yale University Press, New Haven, CT. 338p.

Mozingo, Hugh N. 1987. Shrubs of the Great Basin. University of Nevada Press, Reno, NV. 342p.

Mueggler, W. F. and W. L. Stewart. 1980. Grassland and Shrubland Habitat Types of Western Montana. USDA Forest Service, Intermountain Research Station, General Technical Report INT-66, Ogden, UT. 154p.

Mueller-Dombois, Dieter and Heinz Ellenberg. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons. New York, NY. 547 p.

Shultz, Leila M. 1984. Taxonomic and geographic limits of *Artemisia* subgenus *Tridentatae* (Beetle) McArthur (*Asteraceae*: *Anthemideae*). pp. 20-28 *In* Proceedings- Symposium on the Biology of *Artemisia* and *Chrysothamnus*. USDA Forest Service General Technical Report INT-200, Intermountain Research Station, Ogden, UT. 398 p.

Simon, Steven A. 1990. Fire effects from prescribed underburning in central Oregon ponderosa pine plant communities: first and second growing season after burning. pp. 93-109. *In* Fire in Pacific Northwest Ecosystems. Thomas E. Bedell, editor.. Department of Rangeland Resources, Oregon State University, Covallis, OR. 145p.

Smith, Bradley G. Undated. EcoAID Programs, Demo Distribution.

Steele, Robert, Stephen V. Cooper, David M. Ondov, David W. Roberts, and Robert D. Pfister. 1983. USDA Forest Service, Intermountain Research Station, General Technical Report INT-144, Ogden, UT. 122p.

Tart, David L. 1994. Preliminary Mountain Big Sagebrush Plant Associations of the Pinedale Ranger District. Bridger-Teton National Forest. Unpublished report. 32p.

Tiedeman, J. A., R. E. Francis, C. Terwilliger Jr., and L. H. Carpenter. 1987. Shrub-Steppe Habitat Types of Middle Park, Colorado. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Research Paper RM-273. Fort Collins, CO. 20p.

Tweit, Susan J. and Kent E. Houston. 1980. Grassland and Shrubland Habitat Types of the Shoshone National Forest. USDA Forest Service, Rocky Mountain Region, Shoshone National Forest. Cody, WY. 143p.

USDA. 1983. Soil Survey Manual. USDA Handbook No. 18. Washington D.C. 437p.

USDA Forest Service. 1937. Range Plant Handbook. Washington D.C. 848p. (Reprinted by Dover Publications. Mineola, NY.)

USDA Forest Service. 1991. Ecological Classification and Inventory Handbook. Amendment 2090.11-91-1. Forest Service Handbook. Washington D.C. 18p.

USDA Forest Service. 1993. National Hierarchical Framework of Ecological Units. ECOMAP (P. Avers, D.T. Cleland, H. McNab, M.E. Jensen, R.G. Bailey, C.B. Goudey, W.E. Russell). Washington D.C. 18p.

Winward, A. H. 1980. Taxonomy and Ecology of Sagebrush in Oregon. Oregon State University Agricultural Experiment Station Bulletin 642. Corvallis OR. 15 p.

Winward, A. H. 1991. A renewed commitment to management in sagebrush grasslands. *In*: Management in the Sagebrush Steppes. Oregon State University Agricultural Experiment Station Special Report 880. Corvallis OR. pp.2-7.

Winward, A. H. and E. W. Tisdale. 1977. Taxonomy of the Artemisia Tridentata Complex in Idaho. University of Idaho Forest, Wildlife and Range Experiment Station Bulletin Number 19. Moscow, ID. 15p.

Appendix 1. Plant List

Common Name	Scientific Name	Code
FERNS:		
Brittle bladderfern	*Cystopteris fragilis*	CYFR2
Common Spikemoss	*Selaginella densa*	SEDE2
Rockbrake	*Cryptogramma*	CRYPT3
FORBS:		
Agoseris	*Agoseris*	AGOSE
Alpine sagewort	*Artemisia scopulorum*	ARSC
American bistort	*Polygonum bistortoides*	POB16
Annual gentian	*Gentianella amarelle* var. *amarelle*	GEAMA#
Arnica	*Arnica*	ARNIC
Arrowleaf balsamroot	*Balsamorhiza sagittata*	BASA3
Aster	*Aster*	ASTER
Avens	*Geum*	GEUM
Ballhead sandwort	*Arenaria congesta*	ARCO5
Bedstraw	*Galium*	GALIU
Biscuitroot	*Lomatium*	LOMAT
Bitterroot	*Lewisia*	LEWIS
Bladderpod	*Lesquerella*	LESQU
Blazingstar	*Mentzelia*	MENTZ
Blite goosefoot	*Chenopodium capitatum*	CHCA4
Blue flax	*Linum lewisii*	LILE3
Bluebells	*Mertensia*	MERTE
Bluntleaf sandwort	*Arenaria lateriflora*	ARLA15
Brandege's onion	*Allium brandegei*	ALBR
Broadfruit biscuitroot	*Lomatium triternatum* var. *platycarpum*	LOTRP#
Brook saxifrage	*Saxifraga odontoloma*	SAOD2
Broomrape	*Orobanche*	OROBA
Buckwheat	*Erigonum*	ERIOG
Buff fleabane	*Erigeron ochroleucus*	EROC
Buff fleabane	*Erigeron ochroleucus* var. *ochroleucus*	EROCO
Buff fleabane	*Erigeron ochroleucus* var. *scribneri*	EROCS2
Bulbil onion	*Allium geyeri* var. *tenerum*	ALGET
Buttercup	*Ranunculus*	RANUN
Canada thistle	*Cirsium arvense*	CIAR4
Catseye	*Cryptantha*	CRYPT
Cinquefoil	*Potentilla*	POTEN
Clover	*Trifolium*	TRIFO
Colorado columbine	*Aquilegia coerulea*	AQCO
Columbia groundsel	*Senecio integerrimus* var. *exaltatus*	SEINE
Common chickweed	*Stellaria media*	STME2
Common dandelion	*Taraxacum officinale*	TAOF
Common salsify	*Tragopogon dubius*	TRDU
Common stickseed	*Hackelia patens*	HAPA
Common yampa	*Perideridia Montana*	PEMO7
Cushion buckwheat	*Eriogonum ovalifolium*	EROV
Cushion buckwheat	*Erigonum ovalifolium* var. *purpureum*	EROVP2
Cusick's Indian paintbrush	*Castilleja cusickii*	CACU7
Dandelion	*Taraxacum*	TARAX
Darkthroat shootingstar	*Dodecatheon pulchellum*	DOPU
Deathcamas	*Zigadenus*	ZIGAD
Desert groundsel	*Senecio eremophilus*	SEER2
Dock (sorrel)	*Rumex*	RUMEX
Droopflower clover	*Trifolium longipes* var. *reflexum*	TRLOR
Dropseed rockcress	*Arabis pendulocarpa*	ARPE10
Dropseed rockcress	*Arabis pendulocarpa* var. pendulocarpa	ARPEP#

Douglas' dusky maiden	*Chaenactis douglasii*	CHDO
Douglas' knotweed	*Polygonum douglasii*	PODO4
Drummond's campion	*Silene drummondii*	SIDR
Drummond's rockcress	*Arabis drummondii*	ARDR
Eaton's fleabane	*Erigeron eatonii*	EREA
Elk thistle	*Cirsium scariosum*	CISC2
Fernleaf licoriceroot	*Ligusticum filicinum*	LIFI
Field mint	*Mentha arvensis* var. *Canadensis*	MEARC
Field sagewort	*Artemisia campestris*	ARCA12
Fireweed	*Epilobium angustifolium*	EPAN2
Fivenerve helianthella	*Helianthella quinquenervis*	HEQU2
Flattop pussytoes	*Antennaria corymbosa*	ANCO
Flaxleaf plainsmustard	*Schoenocrambe linifolia*	SCLI
Fleabane	*Erigeron*	ERIGE2
Flowery phlox	*Phlox multiflora*	PHMU3
Franklin's phacelia	*Phacelia franklinii*	PHFR
Fremont's groundsel	*Senecio fremontii*	SEFR3
Fringed sagewort	*Artemisia frigida*	ARFR4
Geranium	*Geranium*	GERAN
Gilia	*Gilia*	GILIA
Goldenrod	*Solidago*	SOLID
Goldenweed	*Haplopappus*	HAPLO#
Goosefoot	*Chenopodium*	CHENO
Graceful buttercup	*Ranunculus inamoenus*	RAIN
Grassy deathcamas	*Zigadenus venenosus* var. *gramineus*	ZIVEG
Gray aster	*Aster glacodes*	ASGL3
Green gentian	*Swertia radicata*	SWRA
Greenleaf bluebells	*Mertensia viridis*	MEVI4
Groundsel	*Senecio*	SENEC
Groundsmoke	*Gayophytum*	GAYOP
Hairy clematis	*Clematis hirsutissima*	CLHI
Hairy goldenaster	*Heterotheca villosa*	HEVI4
Hawksbeard	*Crepis*	CREPI
Hawkweed	*Hieracium*	HIERA
Heartleaf arnica	*Arnica cordifolia*	ARCO9
Heartleaf twistflower	*Streptanthus cordatus*	STCO6
Hillside knotweed	*Polygonum sawatchense*	POSA17
Hoary balsamroot	*Balsamorhiza incana*	BAIN
Holboell's rockcress	*Arabis holboellii*	ARHO2
Hood's phlox	*Phlox hoodii*	PHHO
Hook violet	*Viola adunca*	VIAD
Houndstongue hawkweed	*Hieracium cynoglossoides*	HICY
Indian milkvetch	*Astragalus australis*	ASAU4
Indian paintbrush	*Castilleja*	CASTI2
Jessica stickseed	*Hackelia micrantha*	HAMI
Knotweed	*Polygonum*	POLYG4
Larkspur	*Delphinium*	DELPH
Leopard lily	*Fritillaria atropurpurea*	FRAT
Limestone hawksbeard	*Crepis intermedia*	CRIN4
Littleflower penstemon	*Penstemon procerus*	PEPR2
Littleleaf alumroot	*Heuchera parvifolia*	HEPA11
Littleleaf pussytoes	*Antennaria microphylla*	ANMI3
Lobeleaf groundsel	*Senecio multilobatus*	SEMU3
Longleaf fleabane	*Erigeron corymbosus*	ERCO5
Longleaf phlox	*Phlox longifolia*	PHLO2
Longspike Indian paintbrush	*Castilleja pilosa* var. longispica	CAPIL
Longstalk starwort	*Stellaria longipes*	STLO2
Lousewort	*Pedicularis*	PEDIC
Lousiana sagewort	*Artemisia ludoviciana*	ARLU

Low larkspur	*Delphinium bicolor*	DEBI
Lupine	*Lupinus*	LUPIN
Manyflowered stickseed	*Hackelia floribunda*	HAFL2
Manyglands cinquefoil	*Potentilla glandulosa* var. *pseudorupestris*	POGLP2
Manyray goldenrod	*Solidago multiradiata* var. *scopulorum*	SOMUS
Mariposa lily	*Calochortus*	CALOC
Matroot penstemon	*Penstemon radicosus*	PERA2
Matted buckwheat	*Eriogonum caespitosum*	ERCA8
Meadow aster	*Aster campestris*	ASCA6
Meadow pennycress	*Thlaspi parviflorum*	THPA2
Meadowrue	*Thalictrum*	THALI2
Milkvetch	*Astragalus*	ASTRA
Misionbells	*Fritillaria*	FRITI
Monkeyflower	*Mimulus*	MIMUL
Mountain lupine	*Lupinus argenteus* var. *argenteus*	LAURA11
Montain tansymustard	*Descurainia incana*	DEIN5
Mountain tansymustard	*Descurainia incana* var. *incana*	DEINI#
Mountaintrumpet	*Collomia*	COLLO
Narrowleaf mountaintrumpet	*Collomia linearis*	COLI2
Nodding microseris	*Microseris nutans*	MINU
Nodding rockcress	*Arabis demissa* var. *languida*	ARDEL
Northern bedstraw	*Galium boreale*	GABO2
Northwest cinquefoil	*Potentilla gracilis*	POGR9
Northwestern Indian paintbrush	*Castilleja angustifolia*	CAAN7
Nothocalais	*Nothocalais*	NOTHO5
Nuttall's biscuitroot	*Lomatium nuttallii*	LONU3
Nuttall's flaxflower	*Linanthus nuttallii*	LINU3
Nuttall's larkspur	*Delphinium nuttallianum*	DENU2
Nuttall's violet	*Viola nuttallii*	VINU2
Oblongleaf bluebells	*Mertensia oblongifolia*	MEOB
Oneflower helianthella	*Helianthella uniflora*	HEUN
Oneflowered broomrape	*Orobanche uniflora*	ORUN
Orange agoseris	*Agoseris aurantica*	AGAU2
Orange sneezeweed	*Helenium hoopesii*	HEHO5
Oregon bitterroot	*Lewisia rediviva*	LERE7
Owlclover	*Orthocarpus*	ORTHO
Pale agoseris	*Agoseris glauca*	AGGL
Pale agoseris	*Agoseris glauca* var. *dasycephala*	AGGLD
Pale bastard toadflax	*Comandra umbellate* var. *pallida*	COUMP2
Parry's lousewort	*Pedicularis parryi*	PEPA3
Payson's lousewort	*Pedicularis bracteosa* var. *paysoniana*	PEBRP2
Pearly pussytoes	*Antennaria anaphaloides*	ANAN2
Penstemon	*Penstemon*	PENST
Phacelia	*Phacelia*	PHACE
Phlox	*Phlox*	PHLOX
Pine Indian paintbrush	*Castilleja applegatei* var. *viscida*	CAAPV
Pinnate tansymustard	*Descurainia pinnata*	DEPI
Pleated gentian	*Gentiana affinis* var. *affinis*	GEAFA#
Prairie lupine	*Lupinus lefidus* var. *utahensis*	LULEU2
Prairiesmoke	*Geum triflorum*	GETR
Pussytoes	*Antennaria*	ANTEN
Pygmy bitterroot	*Lewisia pygmaea*	LEPY2
Pygmyflower rockjasmine	*Androsace septentrionalis* var. *subulifera*	ANSES
Raceme pussytoes	*Antennaria racemosa*	ANRA
Redowski's tickseed	*Lappula redowskii*	LARE
Redowski's tickseed	*Lappula redowskii* var. *redowskii*	LARER#
Rockcress	*Arabis*	ARABI2
Rocky Mountain penstemon	*Penstemon strictus*	PEST2

Rosy pussytoes	*Antennaria rosea*	ANRO2
Roughseed catseye	*Cryptantha flavoculata*	CRFL6
Round fleabane	*Erigeron compositus* var. *discoideus*	ERCOD
Roundleaf harebell	*Campanula rotundifolia*	CARO2
Sailorscaps shootingstar	*Dodecatheon conjugens*	DOCO
Salsify	*Tragopogon*	TRAGO
Sandwort	*Arenaria*	ARENA
Saxifrage	*Saxifraga*	SAXIF
Scarlet Indian paintbrush	*Castilleja miniata*	CAMI12
Segolily	*Calochortus nuttallii*	CANU3
Shootingstar	*Dodecatheon*	DODEC
Sicklepod rockcress	*Arabis sparsiflora*	ARSP
Silene	*Silene*	SILEN
Silky lupine	*Lupinus sericeus*	LUSE4
Silky phacelia	*Phacelia sericea*	PHSE
Silverleaf milkvetch	*Astragalus argophyllus*	ASAR4
Silvery lupine	*Lupinus argenteus*	LUAR3
Silvery lupine	*Lupinus argenteus* var. *rubricaulis*	LUARR2
Skyrocket gilia	*Ipomopsis aggregata*	IPAG
Sleeping popcornflower	*Plagiobothrys scouleri* var. *hispidulus*	PLSCH
Slender false phlox	*Microsteris gracilis*	MIGR
Slender fleabane	*Erigeron gracilis*	ERGR2
Slender woodlandstar	*Lithophragma tenellum*	LITE4
Small Indian paintbrush	*Castilleja exilis*	CAEX6
Smallflower blue eyed Mary	*Collinsia parviflora*	COPA3
Ssmallflowered anemone	*Anemone parviflora*	ANPA
Smooth fleabane	*Erigeron glabellus* var. *glabellus*	ERGLG
Snowbed whitlowgrass	*Draba crassifolia*	DRCR2
Soft gilia	*Gilia tenerrima*	GITE
Spearleaf stonecrop	*Sedum lanceolatum*	SELA
Spreading fleabane	*Erigeron divergens*	ERDI4
Spreading groundsmoke	*Gaophytum diffusum*	GADI2
Spreadingpod rockcress	*Arabis confines*	ARCO24
Squarestem phlox	*Phlox muscoides*	PHMU4
Starry false-Solomons-seal	*Smilacina stellata*	SMST
Starwort	*Stellaria*	STELL
Stemless goldenweed	*Haplopappus acaulis*	HAAC
Stickseed	*Hackelia*	HACKE
Sticky geranium	*Geranium viscosissimum*	GEVI2
Stickywilly	*Gallium aparine* var. *aparine*	GAAPA#
Stiffleaf penstemon	*Penstemon arenicola*	PEAR
Stonecrop	*Sedum*	SEDUM
Strawberry	*Flagaria*	FRAGA
Subalpine lupine	*Lupinus argenteus* var. *depressus*	LAURD2
Sulphur Indian paintbrush	*Castilleja sulphurea*	CASU12
Sulphur buckwheat	*Eriogonum umbellatum*	ERUM
Tall blacktip ragwort	*Senecio atratus*	SEAT
Tall larkspur	*Delphinium occidentale*	DEOC
Tansymustard	*Descurainia*	DESCU
Tapertip hawksbeard	*Crepis acuminata*	CRAC2
Tapertip onion	*Allium acuminatum*	ALAC4
Taprooted fleabane	*Erigeron radicatus*	ERRA2
Thickleaf goundsel	*Senecio crassulus*	SECR
Thickstem aster	*Aster integrifolius*	ASIN3
Thistle	*Cirsium*	CIRSI
Tickseed	*Lappula*	LAPPU
Timber milkvetch	*Astragalus miser*	ASMI9
Torrey's catseye	*Cryptantha torreyana*	CRTO4
Tuber starwort	*Stellaria jamesiana*	STJA3

Tufted broomrape	*Orobanche fasciculate*	ORFA
Tweedy's gila	*Gilia tweedyi*	GITW
Twin arnica	*Arnica sororia*	ARSO2
Umber pussytoes	*Antennaria umbrinella*	ANUM
Valley yellow violet	*Viola vallicola*	VIVA
Varileaf cinquefoil	*Potentilla diversifolia*	PODI2
Velvet lupine	*Lupinus leucophyllus*	LULE3
Violet	*Viola*	VIOLA
Virginia strawberry	*Fragaria virginiana*	FRVI
Western aster	*Aster occidentalis*	ASOC
Western gromwell	*Lithospermum ruderale*	LIRU4
Western rockjasmine	*Androsace ocidentalis*	ANOC2
Western sweetvetch	*Hedysarum occidentale*	HEOC
Western yarrow	*Achillea millefolium* var. *lanulosa*	ACMIL3
White Mariposa lily	*Calochortus eurycarpus*	CAEU
Whitlowgrass	*Draba*	DRABA
Wholeleaf woollysunflower	*Eriophyllum lanatum* var. *integrifolium*	ERLAI
Wild onion	*Allium*	ALLIU
Willowweed	*Epilobium*	EPILO
Woodland strawberry	*Fragaria vesca*	FRVE
Woodland whitlowgrass	*Draba nemorosa*	DRNE
Woodlandstar	*Lithophragma*	LITHO2
Woollypod milkvetch	*Astragalus purshii*	ASPU9
Wormwood or sagewort	*Artemisia*	ARTEM
Wyoming Indian paintbrush	*Castilleja linariifolia*	CALI4
Wyoming kittentails	*Besseye wyomingensis*	BEWY
Yellow Indian paintbrush	*Castilleja flava*	CAFL7
Yellow owlclover	*Orthocarpus luteus*	ORLU2
Yellowbells	*Fritillaria pudica*	FRPU2
GRASSES:		
Alkali bluegrass	*Poa juncifolia*	POJU
Alpine timothy	*Phleum alpinum*	PHAL2
Arctic bluegrass	*Poa artica* var. *grayana*	POARG3
Bearded wheatgrass	*Elymus trachycaulus* var. *andinus*	ELTRA3
Bentgrass	*Agrostis*	AGROS2
Big bluegrass	*Poa juncifolia* var. *ampla*	POJUA
Bluebunch wheatgrass	*Elymus spicatus*	ELSP3
Bluegrass	*Poa*	POA
Gottlebrush squirreltail	*Elymus elymoides*	ELEL5
Brome	*Bromus*	BROMU
Canby's bluegrass	*Poa secunda* var. *elongata*	POSEE
Cheatgrass brome	*Bromus tectorum*	BRTE
Columbia needlegrass	*Stipa nelsonii*	STNE3
Columbia needlegrass	*Stipa nelsonii* var. *dorei*	STNED2
Columbia needlegrass	*Stipa nelsonii* var. *nelsonii*	STNEN2
Crested wheatgrass	*Agropyron cristatum*	AGCR
Cusick's bluegrass	*Poa cusickii*	POCU3
Cusick's bluegrass	*Poa cusickii* var. *cusickii*	POCUC#
Foxtail	*Alopecurus*	ALOPE
Foxtail barley	*Hordeum jubatum*	HOJU
Fringed brome	*Bromus ciliatus*	BRCI2
Hairgrass	*Deschampsia*	DESCH
Hairy brome	*Bromus commutatus*	BRCO4
Idaho fescue	*Festuca idahoensis*	FEID
Indian ricegrass	*Oryzopsis hymenoides*	ORHY
Inland bluegrass	*Poa interior*	POIN
Intermediate wheatgrass	*Elymus hispidus*	ELHI6
Kentucky bluegrass	*Poa pratensis*	POPR

King's spikefescue	*Hesperochloa kingii*	HEKI
Letterman's needlegrass	*Stipa lettermanii*	STLE4
Little ricegrass	*Oryzopsis exigua*	OREX
Mountain brome	*Bromus carinatus*	BRCA5
Muhly	*Muhlenbergia*	MUHLE
Mutton bluegrass	*Poa fendleriana*	POFE
Needle-and-thread	*Stipa comata*	STCO4
Needle-and-thread	*Stipa comata* var. *intermedia*	STCOI
Needlegrass	*Stipa*	STIPA
Nevada bluegrass	*Poa nevadensis*	PONE3
Nodding brome	*Bromus anomalus*	BRAN
Onespike oatgrass	*Danthonia unispicata*	DAUN
Oniongrass	*Melica*	MELIC
Oniongrass	*Melica bulbosa*	MEBU
Patterson's bluegrass	*Poa pattersonii*	POPA3
Prairie junegrass	*Koeleria macrantha*	KOMA
Pumpelly brome	*Bromus inermis* var. *purpurascens*	BRINP2
Purple oniongrass	*Melica spectabilis*	MESP
Quackgrass	*Elymus repens*	ELRE4
Richardson's needlegrass	*Stipa richardsonii*	STRI2
Sandberg bluegrass	*Poa secunda*	POSE
Sandberg bluegrass	*Poa secunda* var. *incurva*	POSI2
Sandberg bluegrass	*Poa secunda* var. *secunda*	POSES#
Sixweeks fescue	*Festuca octoflora*	FEOC3
Skyline bluegrass	*Poa cusickii* var. *epilis*	POCUE
Slender bluegrass	*Poa gracillima*	POGR
Slender wheatgrass	*Elymus trachycaulus*	ELTR7
Smooth brome	*Bromus inermis*	BRIN2
Spike trisetum	*Trisetum spicatum*	TRSP2
Spreading wheatgrass	*Elymus scribneri*	ELSC4
Thickspike wheatgrass	*Elymus lanceolatus* var. *lanceolatus*	ELLAL#
Ticklegrass	*Agrostis scabra*	AGSC5
Timber oatgrass	*Danthonia intermedia*	DAIN
Timothy	*Phleum pratense*	PHPR3
Wasatch bluegrass	*Poa curta*	POCU
Western needlegrass	*Stipa occidentalis*	STOC2
Wheatgrass	*Agropyron*	AGROP2
Wheeler's bluegrass	*Poa nervosa* var. *wheeleri*	PONEW
GRASSLIKES:		
Blackroot sedge	*Carex elynoides*	CAEL3
Douglas' sedge	*Carex douglasii*	CADO2
Dryland sedge	*Carex xerantica*	CAXE
Dunhead sedge	*Carex phaeocephala*	CAPH2
Hood's sedge	*Carex hoodii*	CAHO5
Obuse sedge	*Carex obtusata*	CAOB4
Quill sedge	*Carex tenera*	CATE3
Raynolds' sedge	*Carex raynoldsii*	CARA6
Ross' sedge	*Carex rossii*	CARO5
Rush	*Juncus*	JUNCU
Sedge	*Carex*	CAREX
Sheep sedge	*Carex illota*	CAIL
Showy sedge	*Carex spectabilis*	CASP5
Spike sedge	*Carex nardina*	CANA2
Threadleaf sedge	*Carex filifolia*	CAFI
Valley sedge	*Carex vallicola*	CAVA3
SHRUBS:		
Alkali sagebrush	*Artemisia longiloba*	ARLO9
Alpine prickly currant	*Ribes montigenum*	RIMO2
Antelope bitterbrush	*Purshia tridentate*	PUTR2

Black chokecherry	*Prunus virginiana* var. *melanocarpa*	PRVIM
Common juniper	*Juniperus communis* var. *depressa*	JUCOD
Creeping Oregon-grape	*Berberis repens*	BERE
Currant	*Ribes*	RIBES
Gray horsebrush	*Tetradymia canescens*	TECA2
Gray low sagebrush	*Artemisia arbuscula* ssp. *Arbuscula*	ARARA
Green rabbitbrush	*Chrysothamnus viscidiflorus*	CHVI8
Hotsprings sagebrush	*Artemisia arbuscula* ssp. *Thermopola*	ARART
Kinnikinnick	*Arctostaphylos uva-ursi*	ARUV
Lanceleaf rabbitbrush	*Chrysothamnus viscidiflorus* var. *lanceolatus*	CHVIL6
Mountain big sagebrush	*Artemisia tridentata* var. *pauciflora*	ARTRP4
Mountain silver sagebrush	*Artemisia cana* ssp. *Viscidula*	ARCAV2
Myrtle pachistima	*Pachistima myrsinites*	PAMY
Plains pricklypear	*Opuntia polycantha* var. *polycantha*	OPPOP
Rose	*Rosa*	ROSA5
Rubber rabbitbrush	*Chrysothamnus nauseosus*	CHNA2
Saskatoon serviceberry	*Amelanchier alnifolia*	AMAL2
Shrubby cinquefoil	*Potentilla fruticosa*	POFR4
Snowbrush ceanothus	*Ceanothus velutinus*	CEVE
Spiny phlox	*Leptodactylon pungens*	LEPU
Subalpine big sagebrush	*Artemisia tridentata* ssp. *Spiciformis*	ARTRS2
Twinberry honeysuckle	*Lonicera involucrate*	LOIN5
Utah mountain snowberry	*Symphoricarpos oerophilis* var. *utahensis*	SYORU
Vasey big sagebrush	*Artemisia tridentata* var. *vaseyana*	ARTRV2
Wax currant	*Ribes cereum* var. *pedicellare*	RICEP
Woods' rose	*Rosa woodsii*	ROWO
Wyoming big sagebrush	*Artemisia tridentata* ssp. *Wyomingensis*	ARTRW8
TREES:		
Limber pine	*Pinus flexilis*	PIFL2
Pine	*Pinus*	PINUS
Rocky Mountain Douglas-fir	*Pseudotsuga menziesii* var. *glauca*	PSMEG
Rocky Mountain juniper	*Juniperus scopulorum*	JUSC2
Quaking aspen	*Populus tremuloides*	POTR5
Subalpine fir	*Abies lasiocarpa*	ABLA
Tall lodgepole pine	*Pinus contorta* var. *latifolia*	PICOL
Whitebark pine	*Pinus albicaulis*	PIAL

Appendix 2. Sagebrush Taxonomy

The big sagebrush taxa used to define PNV types on the Pinedale Ranger District have been identified and named based on Goodrich *et al*. (1985). The scientific and common names of the three taxa included in this PNV classification are as follows:

Artemisia tridentata ssp. *spiciformis*	subalpine big sagebrush
Artemisia tridentata var. *vaseyana*	Vasey big sagebrush
Artemisia tridentata var. *pauciflora*	mountain big sagebrush

Varieties *vaseyana* and *pauciflora* are subdivisions of subspecies *vaseyana* (Goodrich *et al*. 1985). Subspecies *vaseyana* has traditionally been referred to as mountain big sagebrush. Most of the specimens and populations referred to as mountain big sagebrush are variety *pauciflora* (personal communication with Alma Winward). To maintain continuity, this classification uses mountain big sagebrush as the common name for variety *pauciflora* and Vasey big sagebrush as the common name for variety *vaseyana*. Subalpine big sagebrush is the most accepted common name for subspecies *spiciformis*. However, some past studies have misidentified variety *vaseyana* as subspecies *spiciformis*.

The morphological characteristics of these three big sagebrush taxa are compared in Table 6. This comparison is based on descriptions and taxonomic keys by Goodrich *et al*. (1985), Beetle and Johnson (1982), Winward and Tisdale (1977), Winward (1980), Dorn (1992), and personal communication with Alma Winward. The taxonomic key on the following pages is based on the same sources.

Table 6. Comparative Morphology of Three Taxa of Big Sagebrush.

Characteristic	**subalpine big sagebrush** ssp. *spiciformis*	**Vasey big sagebrush** ssp. *vaseyana* var. *vaseyana*	**mountain big sagebrush** ssp. *vaseyana* var. *pauciflora*
Flowers per head:	7 to 18 (mostly 10 to 18)	7 to 11	4 to 6
Width of head:	3 to 5 mm	1.5 to 3 mm	1.5 mm or less
Inflorescence:	spike or raceme-like with relatively few heads		panicle with numerous heads
Persistent leaf lobes:	variable in size, shape, and number; many lobes with pointed tips	relatively similar in size and shape, usually 3 in number; lobes with rounded tips	
Persistent leaf shape:	bases of lobes uneven	bases of lobes even, leaf widest at base of lobes	bases of lobes even, leaf widest slightly below base of lobes
Growth form:	mostly multi-stemmed	mostly single-stemmed or two-stemmed	
Sprouting:	often resprouts after fire	do not resprout after fire	
Layering:	plants occasionally layering		plants do not layer

Key to Sagebrushes (*Artemisia*) of Wyoming

David Tart and Alma Winward
August 1996 (Revised December 2001)

1a. Persistent leaves all or mostly entire, linear to narrowly lanceolate.

1a

2a. Mature plants 3 to 5 feet tall. Leaves strongly silvery-green pubescent. Outer involucral bracts canescent . . . . . ***A. cana* ssp. *cana***

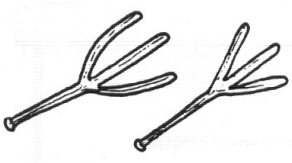
2b. Mature plants less than 40 inches tall. Leaves sparsely pubescent and gray-green. Outer involucral bracts sparsely pubescent . . . . . ***A. cana* ssp. *viscidula***

1b. Persistent leaves 3-lobed or deeply 3-cleft.

1b

3a. Persistent leaves deeply cleft (lobes 3 times as long as wide or longer).

4a. Inflorescence a narrow to open panicle. Upper bracts of inflorescence much longer than the flower heads. The basal part of the leaf no wider than the lobes.



5a

5a. Mature plants 1 to 3 feet tall. Leaves rarely over 2cm long. Panicle open to narrow. . . . . ***A. tripartita* ssp. *tripartita***

5b. Mature plants less than 10 inches tall. Leaves often over 2cm long. Panicle narrow. . . . . ***A. tripartita* ssp. *rupicola***

4b. Inflorescence a sparse spike or raceme. Upper bracts of inflorescence shorter to only slightly longer than the flower heads. The basal part of the leaf wedge-shaped (widened below the teeth). . . . . ***A. arbuscula* ssp. *thermopola***

4b

3b. Persistent leaves shallowly lobed (lobes less than 3 times as long as wide).

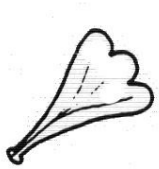
3b

6a. Persistent leaves bell-shaped with middle lobe overlapping the two outer teeth.

6a

7a. Inflorescence a sparse spike or raceme, flowering by mid summer, mature plants less than 20 inches tall. . . . . ***A. longiloba***

7b. Inflorescence a raceme or narrow panicle, flowering in early fall, mature plants 18 to 36 inches tall. . . . . ***A. "g."*** (taxonomy yet to be resolved)



6b

6b. Middle lobe of persistent leaves rarely overlaps the two outer lobes.

8a. Mature plants less than 20 inches tall.

9a. Inflorescence with brown stalks that persist into the following year. Leaves dark green, shiny, and sticky. . . . . ***A. nova***

9b. Inflorescence with gray, weakly persistent stalks. Leaves grayish green, not shiny or sticky.

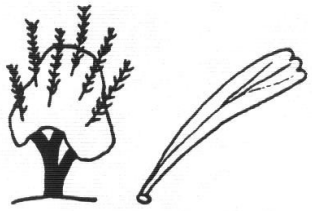
10a. Inflorescence a narrow panicles; the heads clustered. . . . . ***A. tridentata* spp. *wyomingensis***

10b. Inflorescence a sparse spike or raceme; the heads single or 2 to 3 together. . . . . ***A. arbuscula* ssp. *arbuscula***

8b. Mature plants over 20 inches tall.

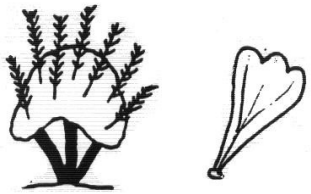
11a. Uneven-topped shrubs with flowering and vegetative twigs intermingled.

12a. Mature plants mostly over 40 inches tall, often with a discernable main trunk. Persistent leaves 4 times as long as wide or longer with straight margins. . . . . ***A. tridentata* ssp. *tridentata***



12a

12b. Mature plants mostly less than 40 inches tall, often quite branched from near base with no discernable main trunk. Persistent leaves less than 4 times as long as wide with curved margins. . . . . ***A. tridentata* ssp. *wyomingensis***



12b

11b. Even-topped shrubs with flowering stalks well elevated above the vegetative twigs; the flowering stalks mostly over twice as long as the subtending vegetative twigs.

13a. Mature seed heads present; individual flowers discernable. . . . . FLORAL KEY (14)

13b. Seed heads immature; individual flowers not discernable. . . . . VEGETATIVE KEY (18)

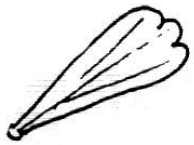
FLORAL KEY

14a. Heads with a maximum of 6 flowers or less.

15a. Mature persistent leaves mostly less than 12mm long, with margins curved outward (bell-shaped). . . . . ***A. tridentata* ssp. *wyomingensis***

15a

15b. Mature persistent leaves mostly longer than 12mm with straight margins. . . . . ***A. tridentata var. pauciflora***

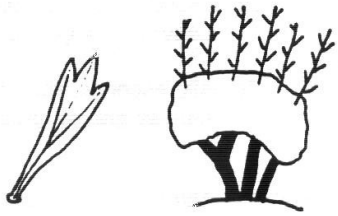


15b

14b. Heads with a maximum of 7 flowers or more.

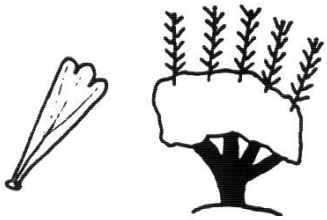
16a. Heads with a maximum of 12 flowers or more. . . . . ***A. tridentata* ssp. *spiciformis***

16b. Heads with a maximum of 11 flowers or less.



17a. Lobes of persistent leaves variable in size, shape, and number; many lobes with pointed tips. Plants mostly multi-stemmed. . . . . ***A. tridentata* ssp. *spiciformis***

17a



17b. Persistent leaves mostly with 3 rounded lobes; each usually similar in size and shape. Plants mostly single-stemmed or two-stemmed. . . . . ***A. tridentata* var. *vaseyana***

17b

VEGETATIVE KEY

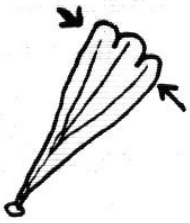
18a. Mature persistent leaves mostly less than 12mm long, with margins curved inward (bell-shaped). . . . . ***A. tridentata* ssp. *wyomingensis***

18b. Mature persistent leaves mostly longer than 12mm, with straight margins.

19a. Lobes of persistent leaves variable in size, shape, and number; many lobes with pointed tips. Plants mostly multi-stemmed and tend to resprout after fire. . . . . ***A. tridentata* ssp. *spiciformis***

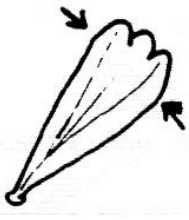
19a

19b. Persistent leaves mostly with 3 rounded lobes, each usually similar in size and shape. Plants mostly single-stemmed or two-stemmed and do not resprout after fire.



20a. Persistent leaves widest at base of lobes. Inflorescence a spike or raceme with relatively few heads. Plants occasionally layering. . . . . ***A. tridentata* var. *vaseyana***

20a



20b. Persistent leaves widest slightly below the base of the lobes. Inflorescence a panicle with numerous heads. Plants do not layer. . . . . ***A. tridentata* var. *pauciflora***

20b

Appendix 3. Field Sampling and Data Analysis Methods

This PNV classification was developed as part of the Bridger-East Ecological Unit Inventory. As a result, the classification of big sagebrush PNV types and the mapping of ecological types (based on PNV and soils) were conducted simultaneously. Since classification of PNV types normally precedes mapping them, this presented some logistical difficulties. Simultaneous classification and mapping involves a lot of back tracking and reduces the efficiency of both processes. It is possible only because both processes involve searching for entities that repeat across the landscape in a discernable pattern. However, PNV classification and ecological mapping differ fundamentally in sampling strategy and plot location methods. These differences are discussed below.

Sampling Strategy

The sampling strategy for a PNV classification includes two objectives. First, sample the entire geographic and environmental range (within the study area) of the vegetation being classified. Second, sample only in areas with minimal evidence of past disturbance (Daubenmire 1970). The EUI process facilitated the first objective by stratifying the landscape for sampling. This was done by subdividing the survey area into subsections (see pages 3-4) and delineating premapping units using aerial photography and satellite imagery. The EUI process was not totally compatible with the second objective. Mapping requires that all areas be sampled, not just the undisturbed areas. Sampling disturbed areas increased the time required to sample enough undisturbed plots to develop a PNV classification. However, the sampling of disturbed vegetation along with the soil data required by the EUI eventually allowed disturbed stands to be assigned to a PNV type. This allowed the effects of disturbance on each PNV type to be described and used in developing management interpretations.

Due to the nature of plant community classification procedures, it is most efficient to sample across the entire study area each field season. This is the fastest way to develop a classification applicable to the entire study area. The EUI process was not compatible with this strategy because mapping can be done more efficiently by starting at one end of the survey area and working toward the other end.

Plot Location

The most efficient approach to locating plots for PNV classification is to locate samples “subjectively without bias” (Mueller-Dombois and Ellenberg 1974). This means that sample points are carefully selected to be homogenous (*i.e.* not along ecotones and on a uniform slope), undisturbed, and representative of communities that repeat across the landscape; but not selected because they “fit” a preconceived community type. The EUI process was not fully compatible with this approach for three reasons:

1. The premapping process involves developing a concept, or hypothesis, about what plant communities and soils should occur in each map unit. These preconceived ideas tend to bias the location of the initial sample points in a map unit. However, the expected PNV was usually a broad category such as “sagebrush” which did not greatly bias sample placement. Expectations regarding soil types were often more specific and had a dominant influence on sample location. Once a particular combination of plant community and soil type was determined to be a component of a map unit, additional sampling was biased toward matching that combination. This is an inherent part of the mapping process, especially with limited time and manpower.

2. Lack of disturbance was not a requirement in locating EUI samples. This was because landform and slope position are considered to be more important than plant communities in locating representative soil samples, and because undisturbed vegetation was very hard to find in some areas. When more than one location was considered representative from a soil perspective, the least disturbed stand was sampled.

3. A truck mounted backhoe was used to dig soil pits in the roaded parts of the survey, so accessibility to vehicles was sometimes a limiting factor in locating sample points. In some cases undisturbed areas were not accessible to the backhoe. In other cases the only areas accessible to vehicles were ecotonal. This is because roads are often located on slope breaks.

The above constraints are an inherent part of mapping ecological types based on soils and vegetation. They are a necessary part of the process, but they are often inconsistent with the sampling criteria typically

used in developing a PNV classification. These constraints were mitigated by sampling vegetation separately from soils whenever an opportunity arose. This allowed sampling of sagebrush communities over more of the survey area that was mapped in one field season. It also provided opportunity to look for and sample undisturbed stands. The data set for this classification includes 162 joint soil/vegetation samples and 100 additional vegetation samples. The PNV classification included assigning plots to one of three seral stages. The joint soil/vegetation samples were 17 percent late, 30 percent mid, and 53 percent early seral. In contrast, 32 percent of the additional vegetation plots were late seral, with 32 percent mid and 36 percent early.

Field Sampling Methods

Vegetation plots were usually circular with a radius of 36 feet (an area of 375 square meters). The plot center was marked with surveyor's flagging, then the perimeter was marked in quarters by pacing from the plot center. Plot shape and/or size was occasionally adjusted to avoid ecotones or microsite variation. All of the vascular plants occurring in the plot were listed, then the canopy cover of each species was estimated and recorded. **Canopy cover** is "the vertical projection of a polygon drawn about the extremities of the undisturbed foliage of a plant" (Daubenmire 1970). Canopy cover was estimated to the nearest one percent for values less than 10 percent, and to the nearest five percent for values greater than 10 percent. Plants present with less than one percent cover were recorded as a trace. On a 375 square meter plot a 6.5 by 6.5 foot square represents one percent cover. The total canopy cover of each life form (shrubs, grasses, and forbs) was also estimated, taking overlap between species into account.

In addition to canopy cover, ground cover was also estimated for each plot. Ground cover was recorded by the following categories: bare soil, rock, litter, wood, mosses and lichens, basal vegetation, and standing water. On most plots rock was subdivided into bedrock, gravel, cobbles, stones, and boulders. These were estimated in a manner similar that used for canopy cover.

Several environmental factors were also recorded at each plot. These included landform, slope position, slope shape, parent material, elevation, azimuth, and percent slope. Mean annual precipitation was estimated for each plot using the procedure described in Appendix 4. Ground surface disturbance and evidence of animal use were also recorded for each plot.

On most jointly sampled plots a complete soil pedon description was done using the methods in the Soil Survey Manual (USDA 1993). When the EUI sampling objective was only to confirm the composition of a map unit, only a partial soil description was required. Complete soil pedon descriptions were recorded on 153 plots. When attempting to correlate vegetation characteristics and soil properties, the soil pit should ideally be located near the center of the plot (Daubenmire 1970). This was not always possible due to some of the constraints discussed above, but the soil pits were always within the perimeter of the vegetation plot.

For more detailed descriptions of the data collected refer to the data dictionary for the Bridger-East EUI.

Data Analysis Methods

Floristic, environmental, and soil data were entered into a relational database developed using Paradox 4.0 (Borland International 1992), and later upgraded to Paradox 4.5 for Windows (Borland International 1992). Data was analyzed using EcoAID (Smith undated), an ecological data analysis program, and DECORANA(Hill 1979), an ordination program. EcoAID was also used to transfer data from the relational database to the DECORANA program. See Gauch (1982) for a very readable discussion of ordination.

DECORANA was used to identify groups of associated species and groups of plots with similar species composition. These groups were further evaluated using association tables and synthesis (or summary) tables (see Mueller-Dombois and Ellenberg 1974) produced using EcoAID and Paradox. Environmental variables were included in these tables along with the floristic data so that the environmental distributions of tentative PNV types could be compared. Environmental distributions of tentative types, and sometimes individual species, were also compared graphically (*e.g.* figure 2). Due to the large number of disturbed plots in the data set, environmental distinctions as well as floristic differences were required in defining plant associations. Once the PNV types were defined, ordination and association tables were used to assign plots to seral stages within each PNV type.

Appendix 4. Procedure for Estimating Mean Annual Precipitation

After acquiring all available precipitation data within and near the Bridger-East EUI survey area, some considerable discrepancies were noted between the data and the Wyoming Average Annual Precipitation Map (Soil Conservation Service and National Weather Service 1983). For example, the Gros Ventre Summit SNOTEL site averaged 23.4 inches of precipitation from 1977 through 1992, while the precipitation map showed an average annual precipitation of 50 inches for the same location, based on data for 1941 through 1970. Previous personal experience indicated that systematic errors in the precipitation map were much more likely than a massive climate change between 1970 and 1977. So, it was decided to use the data available from SNOTEL sites and other weather stations in and near the survey area to estimate mean annual precipitation.

The procedure developed for field use is presented first, then the development of the procedure is described.

Procedure for estimating mean annual precipitation

1. Determine location and elevation of plot from a USGS topographic quad.

2. Use the map of climatic zones (figure 5) to determine the zone in which the plot is located.

3. Using Table 7, read down the column for that zone to the first number greater than the elevation of the plot, then read from that number to the right hand column to find the estimated precipitation for the plot.

Development of the Procedure

The above procedure was developed by using pairs of weather stations within or adjacent to the survey area to develop linear equations expressing precipitation as a function of elevation. Because the data is local it more accurately reflects the effects of storm tracks and topographic barriers than the state precipitation map.

The basic data analysis for this procedure was developed in 1993. More precipitation data has become available since then, but the basic calculations have not been redone. This is because the results would be unlikely to change significantly.

Available Data

Long term precipitation data was available from four stations in or near the survey area: Pinedale, Elkhart Park, Big Sandy Opening, and Bondurant 3NW. Records at these stations go back to 1960, but due to gaps in data collection they had only 25 years of common data between 1964 and 1992. Short term data was from SNOTEL sites at East Rim Divide, Gros Ventre Summit, Loomis Park, New Fork Lakes, Kendall Guard Station, Cora, and Christina Lake. These sites were installed in either 1977 or 1986 and had common data from 1986 to 1992. Additional precipitation data was available from the U.S. Forest Service Air Resource Management Program. Data from 1986 to 1992 was available from the following stations: Pinedale 6N, Hobbs Lake, and Black Joe Lake.

In addition to the four stations with long term data, ten stations had precipitation data for 1986 through 1992. One long term station, Bondurant 3NW, was missing some data for 1986, so that value was estimated based on the 1986 values for Pinedale and Elkhart Park. Such estimates are not ideal but they are commonly used to deal with missing precipitation data (Johnson and Dart 1982). Estimating this one value completed the data for 1986 and allowed the short term stations to be compared to the long term stations over a seven year period instead of six years. It also provided 26 years of common data for the long term stations.

Even though a 30 year average is the standard for describing normal annual precipitation, it was decided not to use additional estimates to provide a 30 year period. Instead mean annual precipitation was based

Figure 5. Map of Climatic Zones for Estimating Mean Annual Precipitation

Table 7. Mean Annual Precipitation as a Function of Elevation by Climatic Zone.

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Est'd Precip
				7360	7371	7857	7517	7054	11
				7460	7525	7973	7636	7208	12
				7560	7678	8089	7755	7362	13
				7660	7832	8206	7874	7516	14
				7760	7986	8322	7993	7670	15
				7860	8140	8438	8112	7823	16
				7960	8294	8555	8231	7977	17
				8060	8447	8671	8350	8131	18
				8160	8601	8787	8469	8285	19
				8260	8755	8903	8588	8439	20
				8403	8909	9020	8707	8592	21
7884	7677		7600	8715	9063	9136	8826	8746	22
7950	7782		7833	9028	9216	9252	8945	8900	23
8016	7886		8066	9340	9370	9369	9064	9054	24
8081	7990	8372	8298	9454	9454	9454	9183	9208	25
8147	8094	8565	8531	9521	9521	9521	9302	9361	26
8213	8198	8757	8763	9588	9588	9588	9421	9515	27
8279	8303	8949	8996	9655	9655	9655	9540	9669	28
8345	8407	9141	9229	9722	9722	9722	9659	9823	29
8410	8511	9334	9461	9789	9789	9789	9778	9977	30
8476	8615	9526	9693	9856	9856	9856	9897	10130	31
8542	8719	9718	9926	9923	9923	9923	10016	10284	32
8608	8824	9911	9990	9990	9990	9990	10135	10438	33
8674	8928	10103	10058	10058	10058	10058	10254	10592	34
8739	9032	10295	10125	10125	10125	10125	10373	10746	35
8805	9136	10488	10192	10192	10192	10192	10492	10899	36
8871	9240	10680	10259	10259	10259	10259	10611	11053	37
8937		10872	10326	10326	10326	10326	10730	11207	38
9003		11064	10393	10393	10393	10393	10849	11361	39
9068		11257	10460	10460	10460	10460	10968	11515	40
9134		11449	10527	10527	10527	10527	11087	11668	41
9200		11641	10594	10594	10594	10594	11206	11822	42
			10661	10661	10661	10661	11325	11976	43
			10729	10729	10729	10729	11444	12130	44
			10796	10796	10796	10796	11563	12284	45
			10863	10863	10863	10863	11682		46
			10930	10930	10930	10930	11801		47
			10997	10997	10997	10997	11902		48
			11064	11064	11064	11064	12039		49
			11131	11131	11131	11131	12158		50
			11198	11198	11198	11198			51
			11265	11265	11265	11265			52
			11332	11332	11332	11332			53
			11400	11400	11400	11400			54
			11467	11467	11467	11467			55
			11534	11534	11534	11534			56
			11601	11601	11601	11601			57
			11668	11668	11668	11668			58
			11735	11735	11735	11735			59
			11802	11802	11802	11802			60

on the 26 years for which the four long term stations all had data. This approach seemed more reasonable than adding several more estimates to the long term data. The yearly values for these four stations are shown in Table 8. The seven years of common data were used to estimate a long term mean annual precipitation for each of the short term stations. This procedure is described below.

Estimation of Long Term Mean Precipitation for Short Term Stations

For each long term station, the 26 year mean and a seven year mean (1986 to 1992) were calculated (Table 8). The ratio between these two means was calculated for each long term station by dividing the 26 year mean by the seven year mean. These values were as follows:

Station	Code	26 yr Mean	÷	7 yr Mean	=	Ratio
Big Sandy Opening	BSO	24.8		24.0		1.03
Bondurant 3NW	BON	20.5		16.4		1.25
Elkhart Park	ELK	24.7		24.2		1.02
Pinedale	PIN	11.5		10.7		1.07

Depending on proximity and observed weather patterns, one or two long term stations were selected to estimate the ratio of the long term mean to the seven year mean for each short term station. When two long term stations were used their ratios were averaged. The ratio was then multiplied times the seven year mean for the short term station to estimate its long term mean annual precipitation. The results were as follows:

Short term station	Code	7 yr Mean	x	Ratio	=	26 yr Mean	Long term Stations
East Rim Divide	RIM	20.0		1.16		23.2	BON, PIN
Loomis Park	LOO	26.7		1.045		27.9	ELK, PIN
Kendall Guard Station	KEN	22.1		1.045		23.1	ELK, PIN
Gros Ventre Summit	GVS	23.8		1.16		27.6	BON, PIN
Hobb's Lake	HOB	34.7		1.02		35.4	ELK
Cora	COR	10.8		1.045		11.3	ELK, PIN
New Fork Lakes	NEW	20.4		1.045		21.3	ELK, PIN
Pinedale 6N	PI6	10.9		1.07		11.7	PIN
Black Joe Lake	BLA	33.4		1.03		34.4	BSO
Christina Lake	CHR	29.6		1.03		30.5	BSO

The stations used to estimate mean annual precipitation for sample points of the Bridger-East EUI are listed below. The value for each station on the Wyoming precipitation map is shown for comparison.

Station	Code	Elevation	Mean Ann. Precip.	Wyoming Map Precip.
Black Joe Lake	BLA	10,240	34.4	45
Christina Lake	CHR	9,980	30.5	31
Cora	COR	7,340	11.3	14
East Rim Divide	RIM	7,930	23.2	24
Big Sandy Opening	BSO	9,100	24.8	19
Elkhart Park	ELK	9,400	24.7	23
Gros Ventre Summit	GVS	8,775	27.6	50
Hobb's Lake	HOB	10,120	35.4	30
Kendall Guard Station	KEN	7,740	23.1	27
Loomis Park	LOO	8,240	27.9	25
New Fork Lakes	NEW	8,340	21.3	18
Pinedale	PIN	7,200	11.5	11
Pinedale 6N	PI6	7,880	11.7	16

Table 8. Yearly Precipitation (in inches) for Long and Short Term Stations.

	Long Term Stations				Short Term Stations									
Year	BSO	BON	ELK	PIN	BLA	CHR	COR	RIM	GVS	HOB	KEN	LOO	NEW	PI6
1964	19.5	19.3	17.5	10.2										
1965	27.0	28.3	28.3	12.9										
1966	19.5	19.5	20.2	10.1										
1967	33.6	21.2	27.9	12.0										
1968	23.6	21.9	29.5	15.5										
1969	22.8	16.1	20.5	11.8										
1970	18.2	19.9	25.1	10.8										
1971	29.2	26.5	29.3	9.4										
1972	25.2	40.7	27.5	14.3										
1973	23.3	26.4	22.6	12.0										
1974	23.1	23.4	18.8	7.1										
1975	23.8	20.2	22.1	9.1										
1976	28.4	23.2	25.2	11.9										
...														
1980	26.9	18.6	20.5	11.5										
1981	21.6	12.8	20.5	9.4										
1982	33.1	24.9	33.6	16.6										
1983	27.2	18.2	30.7	16.8										
1984	26.4	22.4	29.5	14.9										
1985	23.9	13.3	23.4	8.7										
1986	35.5	21.9*	34.1	11.9	54.0	44.9	15.5	28.4	32.6	55.9	34.7	39.5	28.5	11.6
1987	24.6	19.0	25.1	13.6	28.2	27.6	16.2	21.2	27.2	28.3	22.0	25.7	23.3	14.3
1988	14.9	11.6	14.9	5.2	21.6	21.1	6.6	13.2	16.7	23.2	15.4	20.4	12.1	5.9
1989	22.4	20.6	24.1	9.5	33.2	30.8	11.6	23.3	24.4	40.0	22.4	28.9	20.5	10.5
1990	24.8	14.4	25.7	10.3	28.4	28.0	7.1	18.0	21.1	31.4	21.6	25.6	21.1	11.0
1991	27.2	16.6	25.2	14.9	36.5	30.2	10.4	21.2	26.8	37.9	22.6	28.0	21.5	14.4
1992	18.9	10.9	20.0	9.5	31.7	24.3	8.5	14.6	17.7	26.6	15.9	19.1	15.7	8.3
'64 - '92Avg.	24.8	20.5	24.7	11.5										
'86 - '92 Avg.	24.0	16.4	24.2	10.7	33.4	29.6	10.8	20.0	23.8	34.7	22.1	26.7	20.4	10.9

* Value estimated based on other stations and partial data for the year.

Estimation of Annual Precipitation for Sample Points

Several pairs of the above stations (p.93) were used to develop linear equations expressing precipitation as a function of elevation. Pairs of stations were selected based on observed weather patterns and topographic barriers. This method is based on the assumption that over relatively short distances precipitation increases linearly with elevation.

Since two points define a line, the elevation and precipitation of two stations are adequate to derive a linear equation. The first step is to determine the slope of the line by dividing the change in precipitation by the change in elevation between the two station. For example, for Big Sandy Opening and Christina Lake the slope was calculated as follows:

$$\frac{30.5 - 24.8}{9980 - 9100} = \frac{5.7 \text{ in.}}{880 \text{ ft.}} = 0.0065 \text{ in./ft.}$$

So the equation for these two stations was

$$P = (E - 9100) \times 0.0065 + 24.8$$

Where P = precipitation in inches and E = elevation in feet. The other constants in this equation, 9100

and 24.8 are the elevation and precipitation of the lower of the two stations (in this case Big Sandy Opening). To estimate the precipitation of a sample point in the vicinity of Big Sandy Opening and Christina Lake the above equation is applied to the elevation of the plot.

Similar equations were derived for several pairs of stations in order to estimate annual precipitation across the survey area. Each pair of stations and the corresponding equation are listed below:

Stations	Linear Equation
East Rim Divide & Loomis Park	P = (E - 7930) x 0.0152 + 23.2
Kendall G.S. & Loomis Park	P = (E - 7740) x 0.0096 + 23.1
East Rim Divide & Gros Ventre Summit	P = (E - 7930) x 0.0052 + 23.2
Kendall G.S. & Gros Ventre Summit	P = (E - 7740) x 0.0043 + 23.1
Elkhart Park & Hobb's Lake	P = (E - 9400) x 0.0149 + 24.7
Cora & New Fork Lakes	P = (E - 7340) x 0.0100 + 11.3
New Fork Lakes & Elkhart Park	P = (E - 8340) x 0.0032 + 21.3
Cora & Elkhart Park	P = (E - 7340) x 0.0065 + 11.3
Cora & Pinedale 6N	P = (E - 7340) x 0.0007 + 11.3
Pinedale 6N & Elkhart Park	P = (E - 7880) x 0.0086 + 11.7
Big Sandy Opening & Black Joe Lake	P = (E - 9100) x 0.0084 + 24.8
Big Sandy Opening & Christina Lake	P = (E - 9100) x 0.0065 + 24.8

Climatic Zones

The climatic zones shown in figure 5 were developed in order to facilitate consistent use of the above equations. The zone boundaries are based on the locations of the weather stations, observed weather patterns, and locations of topographic barriers. Within each zone, one to three of the above equations are used to calculate precipitation estimates based on elevation. The equation(s) for each zone were used to generate Table 7, which serves as a look-up table to estimate precipitation to the nearest inch. The pairs of weather stations used for each zone are as follows:

Zone 1 East Rim Divide & Loomis Park

Zone 2 Kendall G.S. & Loomis Park

Zone 3 East Rim Divide & Gros Ventre Summit

Zone 4 Kendall G.S. & Gros Ventre Summit, Elkhart Park & Hobb's Lake

Zone 5 Cora & New Fork Lakes, New Fork Lakes & Elkhart Park, Elkhart Park & Hobb's Lake

Zone 6 Cora & Elkhart Park, Elkhart Park & Hobb's Lake

Zone 7 Cora & Pinedale 6N, Pinedale 6N & Elkhart Park, Elkhart Park & Hobb's Lake

Zone 8 Big Sandy Opening & Black Joe Lake

Zone 9 Big Sandy Opening & Christina Lake

Appendix 5. Comparison to Preliminary Classification

The preliminary classification of big sagebrush PNV types (Tart 1994) defined nine plant associations without distinguishing subtaxa of big sagebrush (due to a lack of adequate data). This final classification defines eight plant associations and two subseries. It uses subtaxa of big sagebrush in defining the PNV types and to group them into series. The following table compares the plant associations of the preliminary classification to the plant associations and subseries of this final classification.

Preliminary Classification	Final Classification
ARTRV / FEID - GEVI2 p.a.	ARTRS2 / TRSP2 p.a.
	ARTRV2 / TRSP2 p.a.
ARTRV / FEID - AGTR p.a.	ARTRS2 / ELTR7 p.a.
	ARTRV2 / ELTR7 p.a.
ARTRV / FEID - CAFI p.a.	
ARTRV / FEID - STRI2 p.a.	ARTRV2 / STRI2 p.a.
ARTRV - SYORU / FEID p.a.	ARTRV2 - SYOR2 subseries
ARTRV - SYORU / AGSP p.a.	
ARTRV / FEID - AGSP p.a.	ARTRV2 / FEID - ELSP3 p.a.
	ARTRP4 / FEID - ELSP3 p.a.
ARTRV - PUTR2 / FEID p.a.	
	ARTRV2 - PUTR2 subseries
ARTRV - PUTR2 / AGSP p.a.	ARTRP4 - PUTR2 / ELSP3 p.a.

Appendix 6. Evidence of Animal Use by PNV Type

Evidence of animal use, by species, was recorded for most EUI plots. Use by an animal species was recorded when it could identified by direct observation, identification of scat or tracks, presence of shed antlers, or presence of rodent burrows. The following table lists the percentage of plots in each PNV type with evidence of use by big game animals, domestic livestock, and rodents.

		Percentage of plots with evidence of animal use							
	Sample	Big Game Animals:				Domestic Livestock:			Rodents
PNV Type	Size	Elk	Deer	Antelope	Moose	Cattle	Sheep	Horse	
ARTRS2/TRSP2 p.a.	15	20%	20%	20%	- -	53%	33%	7%	53%
ARTRS2/ELTR7 p.a.	11	27%	9%	9%	9%	82%	- -	- -	27%
ARTRV2/TRSP2 p.a.	10	20%	20%	- -	10%	50%	- -	- -	50%
ARTRV2/ELTR7 p.a.	40	10%	18%	5%	10%	93%	8%	- -	25%
ARTRV2/STRI2 p.a.	7	43%	29%	14%	29%	71%	- -	- -	- -
ARTRV2-SYOR2 sub.	14	36%	21%	- -	- -	57%	- -	- -	29%
ARTRV2/FEID-ELSP3 p.a.	33	36%	21%	6%	9%	91%	- -	6%	15%
ARTRV2-PUTR2 sub.	7	57%	14%	- -	14%	86%	- -	- -	14%
ARTRP4/FEID-ELSP3 p.a.	97	68%	41%	6%	10%	63%	2%	3%	8%
ARTRP4-PUTR2/ELSP3 p.a.	28	75%	50%	7%	4%	25%	- -	4%	- -